

# ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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# ANNALS *of* SURGERY

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## THE CLASSIFICATION OF TUMORS

BY C. MANSELL MOULLIN, M.D. (OXON.)

OF LONDON

CONSULTING SURGEON TO THE LONDON HOSPITAL

THE great variety of tumors makes their classification difficult. No method hitherto suggested can be said to meet all the requirements. The division into simple and malignant, for instance, is convenient, for it furnishes a good working rule in practice, where an opinion to be of any value must be dogmatic, but as a classification it cannot be upheld. There is no such thing as a separate class of malignant growths. No hard and fast line can be drawn between them and other growths. Malignancy is an occasional feature of all classes of tumors, even of those that enjoy the best reputation; and it is not uncommon for a tumor, to all appearance non-malignant, to increase slowly in size for years, or even to remain stationary for a time, and then suddenly to change its character and destroy life in the course of a few months. Nor is there any fixed standard of malignancy. It varies in degree even among tumors that appear to be alike. Malignancy is a clinical feature, and clinical features do not provide a good basis for the classification of pathological growths.

Classification by structure promises better. Broad general lines can be drawn and many groups of tumors can be separated from the rest. In other instances, however, the structural details are so varied and complex that general agreement seems to be almost impossible. Classification by origin is better still. Unhappily, however, the basis usually chosen, the three germinal layers of the embryo, is not sufficiently exact. The layers are not all of equal value, and they do not remain distinct from each other, so that it is often impossible to be certain to which of them a particular growth should be assigned.

Tumors, using the word in its ordinary acceptance, are divided into two classes: One is due to the reproductive power that all tissues naturally possess being suddenly roused into action. The other to changes that should take place in the course of development not being



efficiently carried out. It is not impossible that there is one and the same cause underlying both of these.

I. TUMORS DUE TO THE REPRODUCTIVE POWER OF THE TISSUES

The power of reproducing their like, directly, without assistance from any other source, is the common property of all living things and of all their parts. It belongs to them as their birthright, in the same way as the power of growth, for reproduction is only growth beyond the individual; and it remains with them throughout their lives. The extent to which they make use of this power furnishes the most satisfactory basis for the classification of the tissues and of the tumors that grow from them.

*The Division into Germ Cells and Somatic Cells.*—In the most primitive forms of life, before there is any division of labor, every part of the organism can give birth to buds capable of growing into organisms like the parent. With the advance of organization different duties have to be assigned to different portions of the body, and because the existence of the race depends upon it, the first to be assigned in this way is the function of reproduction. At a very early period one group of cells is marked off for this special object and becomes the germ organ. Henceforth the whole reproductive power of the organism is centred in this. The cells that compose it are the only ones that give birth to buds capable of growing into perfect organisms like the parent.

The rest of the cells, known as somatic cells, have an entirely different duty. They have to carry out the different kinds of work upon which the life and well-being of the individual depend. They are no longer concerned with reproduction. So long as conditions are normal they are never called upon for this, and as they become specialized for other kinds of work, they gradually lose the capacity of carrying it out. The progressive deterioration of their reproductive power is shown as well in the evolution of the race as in the development of the individual. In the earliest days the somatic cells, like the germ cells, can give birth to buds capable of growing into perfect organisms. In the ova of some of the echinodermata, for example, the somatic cells and the germ cells can be displaced artificially, and each will then undertake the functions of the other. Later the somatic cells are only able to reproduce portions of the body, such as limbs, as in the crustacea, and simple organs. Later still, this is beyond them. The only structures they can reproduce, even in embryonic life, when their powers are so much more active, are tissues like their own, and as specialization advances even this fails them.



## THE CLASSIFICATION OF TUMORS

Their power becomes so limited that only the simplest kinds of tissue can be reproduced at all.

This division into germ and somatic cells, founded upon the use they make of their reproductive power, is the primary division of the organism. On it is based the classification of the tissues and of the tumors that grow from them. One class of tumors grows from tissues in which the reproductive power has been raised to the greatest perfection. The other from tissues which originally possessed this power in equal measure, but which never make use of it, so long as conditions remain normal, and therefore gradually lose the capacity of using it.

The characteristic feature of all these tumors, that which distinguishes them from others and from the structures among which they lie, is their independence. They are not able to support themselves, it is true, but their life is distinct from the life of the structure from which they grow. If transplanted to another host, so that they can get supplies equally well, they continue to grow and thrive long after the original parent is dead. They live upon the parent, like a parasite upon its host, drawing all they want from it, doing nothing for it in return, and in certain instances draining it of all its strength until it dies of starvation. These tumors are the offspring of the tissues from which they grow, and belong, not to the same generation, but to the next.

The first beginning of these tumors is in the form of a bud growing out from tissues that are apparently normal. They may develop into organisms almost as perfect as the one from which they grew; or into structures composed of well-formed tissues; or into mere masses of cells heaped together without order or arrangement. Which of these forms the tumor takes (or, in other words, the degree of organization of which the tumor bud is capable) depends upon the stage in the life history of the race that the parent cells had reached at the moment that the bud began to grow. The individual is the epitome of the race. Each cell as it develops passes through all the stages through which its ancestors passed in the course of evolution, and any bud that is given off by the parent cell before it has reached its final form possesses the same powers that the corresponding ancestor possessed in days gone by. The bud that grows from the cells of the early embryo, like those that grow from the tissues of lowly organized forms of animal life, is able to reproduce the organism, more or less perfectly, while that which is given off late in adult life is limited to the production of a growth composed of simple tissues.

The structure of a tumor depends upon that of the parent stem.

It is never so perfect but there is always a general resemblance. The character of the tumor, whether it is malignant or not, depends upon the maturity of the parent cell at the moment the bud began to grow. These tumors may assume many different forms—a form that grows fast, or a form that grows slowly; a form that remains circumscribed and limited, or a form that retains its embryonic characteristics, spreads in all directions and invades other organs. If the parent cell when it gives off the bud is still in the actively growing embryonic stage, the bud will be embryonic too. If it has already reached adult age, the bud will increase in size with proportionate slowness, and push surrounding structures to one side instead of invading them. Every organ and every tissue has its own kind of tumor which resembles it in structure more or less, but which according to the degree of maturity attained by the parent cell, at the moment of its birth, may be benign or malignant, or benign first and malignant afterward, or so evenly balanced between the two that it is impossible to say whether it is one or the other. There is no separate class of malignant tumors; rapidly growing malignant forms occur in all classes.

(a) *Tumors of the Germ Organ and Its Derivatives*.—Nearly all of these spring from the germ organ or the ovary. They rarely grow from the testis, at any rate after the sperm cells are developed, probably because of the high degree of specialization they have attained. It is not possible to arrange these tumors in classes. They form a series almost without a break, ranging from included foetus at one end to ovarian adenomata, mere heaped-up masses of epithelial cells, at the other.

*Included foetus*: In the earliest days of existence the reproductive power of the germ cells is only paralleled by that of the most primitive organisms. Like these the germ cells can give off buds capable of growing into organisms almost as elaborate as the parent one. Tumors of this kind are known as included foetus. They grow from the germ cells before the generative organs are differentiated and occur therefore in both sexes. As a rule, they are met with in the genital area. They may, however, occur in distant parts of the body and then they are due either to the accidental displacement of some of the cells of the germ organ in the course of development, or to the fact that some of the somatic cells have been stimulated into excessive action before their latent reproductive power has lost any of its primitive vigor.

*Internal teratomata*: As the power of direct reproduction diminishes in the course of racial evolution, leaving traces of what it once could

## THE CLASSIFICATION OF TUMORS

do here and there (as where, for instance, generations of certain insects are produced for a time asexually), so too it diminishes in the course of the evolution of the individual. Buds given off by the germ cells in the earliest moments of individual existence grow into structures almost as perfect as the parent. Those formed later, known as internal teratomata, are far less complete. They may be made up of organs presenting a general resemblance to those of the parent, but their structure is imperfect; there is no order in their arrangement, and they are quite unlike anything else in shape and outline.

*Ovarian dermoids and ovarian adenomata:* No hard and fast line can be drawn between internal teratomata and these, which undoubtedly originate from the reproductive power of unfertilized ova, roused into action by some stimulus. There is one long unbroken series of tumors, arising by direct reproduction, first from the germ organ and then from the ovary, ranging from the most complex, produced in the earliest moments of individual existence, to the simplest, which often do not make their appearance until old age.

(b) *Tumors that Grow from Somatic Cells.*—There is no difference between germ and somatic cells at first. Their power of direct reproduction is practically equal. In certain circumstances one group can be made to replace the other and undertake all its duties, and it is possible that some of the complex tumors met with in distant parts of the body, which are usually said to arise from displaced cells of the primitive germ organ, are really due to the still intact reproductive power of somatic cells. The direct reproductive power of the somatic cells, however, very soon falls away as they devote themselves to other duties, and with the possible exception of those I have just mentioned, no tumor bud that grows from somatic cells ever attains a high standard of organization. They may be formed of tissues, more or less well developed, heaped together with a certain amount of order or arrangement, but they are never made up of structures such as organs.

The classification of the tumors that grow from the somatic cells depends upon the classification that is adopted for the tissues themselves. Every tissue has its own kind of tumor, just as it has its own kind of structure. However much one tumor resembles others in general arrangement, it differs from them just as the parent organ differs from the rest. Under the term adenoma, for example, are included all tumors built up on the lines of glandular tissue; but those that grow from the parotid gland are as different from those that grow from the mammary gland as one organ is from the other. So it is with fibromata, lipomata, epitheliomata, and many others. They have



certain general features in common, like the cells from which they grow; but those that grow in one part of the body behave quite differently from those that grow in another, even though we may not be able to detect any difference in their structure; and tumors that grow from such organs as the thyroid and prostate are so different from all others, that they can scarcely be brought into the same scheme of classification. Every organ and every tissue has its own kind of tumor.

## 2. TUMORS DUE TO ERRORS OF DEVELOPMENT

These differ from the tumors caused by the sudden awakening of the reproductive power of the tissues in that they do not possess an independent existence, and that they belong to the same generation as the structure from which they grow, and not to the next.

Irregularities of development may lead to tumors of various kinds, such as inclusion dermoids, but the most important are those that result from its premature arrest.

Development implies not only the progressive advance of tissues that are of use, but also the recession and disappearance of those that have ceased to be of use. It involves not only evolutionary changes, but involutionary ones too. Arrest of either of these may lead to the formation of tumors.

The ordinary meningocele is an instance of the former. The medullary groove fails to close at the proper time, leaving an unprotected place on what will become the outer wall of the organism. As size increases and the tissue pressure with it, this weak place is forced to yield, and the body covering is gradually pushed out farther and farther until at last it forms a cystic tumor the covering of which is the everted floor of the medullary groove.

Instances of the latter are more common. There are many organs present in early life, of which no trace is to be found in later years, and many more of which some small portion only persists because it has been possible to adapt it to other purposes. Disappearance of structures that are no longer of use is part of the normal development of the body. If development is arrested these structures persist. Sometimes they remain stationary and do no harm; but they may continue to increase in size in proportion as the body increases, and to work after a fashion, and then they may grow into the most formidable tumors. Cysts developed from the remains of the hyolingual duct or the Wolffian or Mullerian ducts may not be serious, but those developed in the coccygeal region, in connection with the postanal gut, often lead to the gravest consequences.

## ACUTE DILATATION OF THE STOMACH COMPLICATING OPERATIONS ON THE EXTREMITIES

BY ISIDORE COHN, M.D.

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SINCE the description of the clinical syndrome, now recognized under the name of acute dilatation of the stomach, by Hilton Fagge in 1873 (*Guy's Hospital Reports*), cases have been recognized and theories have been advanced as to the etiologic factors and the sequence of events in the abdominal cavity.

As one reviews the literature several facts become apparent at once: (1) The condition arises in the course of the most varied clinical entities. (2) It may occur at any age and without any previous evidence of disease. (3) Either the pathologic picture is not constant or two or more pathologic conditions produce identical clinical symptoms. (4) The evidence as presented in the literature is confusing and contradictory.

The most complete American reviews have been made by Conner (1907), who was able to collect 102 cases, of which number 5 followed operations on the extremities; and Laffer (1908), who states that "it occurred eleven times after a variety of operations on the extremities." He did not tabulate the cases, nor give the operators' names. This omission on the part of the author was probably due to the apparent unimportance of this phase of the question.

Incidentally, from the recent tabulation of cases by Borchgrevink, it would appear that Laffer's case, following drainage of empyema of the antrum of Highmore, is the first recorded *American* case following an operation on the head and extremities. No subsequent case has been reported so far as I know.

It is well to insert here the previous tabulations of cases by Thomson, Borchgrevink and others:

H. Campbell Thomson, in 1902 ("Acute Dilatation of the Stomach"), collected 44 cases. Of these 6 followed operations on the extremities. A summary of these cases follows:

ALBRECHT (1899): Operation on elbow. Female, aged thirty years. Onset 5 days after operation. Died 11 days after operation. Postmortem: Stomach greatly enlarged.

BOX and WALLACE (1901): Lacerated wound on the knee-joint. Arthrec-

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tomy, amputation. Death. "Dilatation of stomach and duodenum, the dilatation of the latter extending to the place where the duodenum came in front of the lumbar spine."

GOODHART, J. F.: Excision of knee. Male, aged twenty-nine years. Death 75 hours after operation. Postmortem: Stomach dilated, nothing else abnormal except some oedema of the lungs.

HOOD, DONALD (1891): Abscess of lower jaw. Stomach, duodenum and first few inches of ileum dilated.

JESSOP, T. R. (*Lancet*, 1888): Excision of hip. Female, aged twenty-six years; died fourth day after operation. Postmortem: Dilatation of stomach and duodenum "which passed abruptly to a condition of extreme contraction 6 inches below the duodenum."

MORRIS, HENRY (*Transactions Path. Soc.*, London, vol. xxxiv): Male, aged thirty-seven years. Operation on foot. Onset one hour after operation. Death two days later. Postmortem: No notes.

Thomson does not cite *any personal cases which were associated with operations on the extremities.*

Borchgrevink records the following cases (1913):

BRAUN and SEIDEL: External urethrotomy.

P. BULL: Amputatio cruris.

LAFFER (American): Drainage of antrum for empyema.

BAILLET: Exarticulation humeri.

It would seem that there are 10 recorded cases. If we exclude cases having to do with operation on the chest and perineum, we have 9 cases of which data are available in foreign and American literature.

Borchgrevink admits that his statistics must be incomplete so far as American cases are concerned. For that reason and because it has been my misfortune to have had this complication arise following an operation for osteomyelitis of the femur, I undertook to review the literature to tabulate the known cases and, if possible, to add such cases as might be obtained as a result of personal communication with about 125 American surgeons.

I sent out a list of questions of which the following is a copy:

How many cases of post-operative acute dilatation of the stomach have you had, which were not associated with abdominal operations?

Will you please state the nature of the operation?

If possible, please state sex. Age.

Time of onset.

What have been the prominent symptoms?

Method of treatment. Results. Autopsy findings.

More than sixty answers were received as a result of this inquiry



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and I have been able to collect four cases besides my own in which an operation was performed (DuBose, Corbett, Lilienthal, Pilcher) and two cases (DuBose and Rixford) in which the condition followed fracture and "severe trauma" of the lower extremity. From a personal communication of Dr. Frederic J. Cotton it would seem that symptoms of acute dilatation following fractures of the lower extremity and spine are not an uncommon happening in his experience. Quoting from his letter we find, "I have seen perhaps half a dozen such cases in fractures of the femur all of which recovered, and I know of one other such case which died under the picture of obstruction. I have seen a number of cases in which a similar abdominal picture was associated with fractures of the spine, without cord symptoms."

The rarity of the condition in the experience of American surgeons can best be appreciated by quoting from some of the letters which I have received:

DR. CHARLES F. PAINTER, of Boston, states, "I have never *seen* or *heard* of a case of acute dilatation of the stomach following any operation on the extremities."

DR. W. S. BEAR, of Baltimore, "I have had no cases of acute dilatation of the stomach following operation on the extremities."

DR. ALBERT FREIBERG, of Cincinnati, "Although operations upon the extremities predominate in my work and although I have been doing this work for twenty years I have no recollection of any case of this character nor do my records show any."

DR. J. C. BLOODGOOD, in 1907, reported 6 cases of acute dilatation of the stomach, none of which were associated with operations on the extremities. In a personal communication he says, "I do not know of any case that I have had not associated with abdominal operations, except those mentioned in the reprint."

DR. E. H. BRADFORD, of Boston, simply answers, "None," to the question, "How many cases of acute dilatation of the stomach have you had which were not associated with abdominal operations?" A like answer has been received from Drs. Matas, Kavel, J. M. T. Finney, De Witt Stetten, Phemister, Leonard Freeman, H. M. Sherman, J. E. Thompson, A. P. C. Ashhurst, Joseph Rilus Eastman, Dean Lewis, Urban Maes, William Brickner, A. F. Jonas, W. W. Grant, Albert Goldspohn, H. G. Wetherill, Jno. E. Summers, H. G. Sloan, T. W. Huntingdon, J. N. Jackson, L. L. McArthur, J. L. Porter, Floyd McRea, J. F. Binnie, Louis Frank, J. Stewart Rodman, C. N. Dowd, J. Young Brown, J. T. Bottomley, Leo Buerger, L. M. McMurtry, C. E. Ruth, Charles Goodman, D. D. Eisendrath, Moschowitz, Wm. L. Rodman, A. J. Ochsner, W. T. Westmoreland, J. F. Golden, A. E. Halsted, Emile G. Beck, Carl Beck, Duncan Eve, Willard Bartlett, W. A. Bryan.

From the Mayo Clinic at Rochester, I have received replies from Drs. W. J. Mayo, Henderson and Beckman. Dr. W. J. Mayo says, "I think that we have had one or two instances of this kind, but regret that we have thus far been unable to find them."

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Dr. Henderson says the following: "I have never seen a *real* case of acute dilatation of the stomach after an operation on the extremities."

Dr. Beckman says, "We do not recall any cases of acute dilatation of the stomach following operation upon the extremities."

The above replies should be sufficient to convince one of the rarity of the complication, and yet a suggestion of Dr. Duncan Eves in regard to his own experience may aptly be stated here—"I have not had a single case of acute dilatation of the stomach from any cause, at least, if I have I have failed to recognize same and may have ascribed the death, as some of us will do, to some other cause."

I wish to add to the number of recorded cases my own with those of Drs. G. DuBose, J. F. Corbett, H. Lilienthal and L. S. Pilcher.

CASE I.—Case of Dr. F. G. DuBose, Selma, Ala. (personal communication). Patient was a male, aged twenty-four, on whom the doctor put a Lane plate for a fractured femur. The anæsthetic used was ether. Symptoms developed *seven* days after operation and the patient died in fourteen days. No autopsy could be obtained.

CASE II.—Case of Dr. J. F. Corbett (personal communication). The patient was a female, aged twenty-eight years, on whom the doctor did a "resection of the jaw." Symptoms developed twelve hours after operation. Recovery. The anæsthetic used was not stated.

CASE III.—Case of Dr. Howard Lilienthal (personal communication). Male, aged thirty-seven. Operation—resection of elbow. Ether was used; symptoms developed within 48 hours. Recovery.

CASE IV.—Case of Lewis S. Pilcher (personal communication). Female, aged seventy-one. Operation—amputation lower third of thigh for diabetic gangrene of foot. Anæsthetic, nitrous oxide and oxygen. Symptoms developed twelve hours after operation; relieved by repeated lavage. Death on fifth day from diabetic coma. Autopsy—stomach normal; chronic inflammatory changes in pancreas, liver and kidneys.

CASE V.—Case of author. M. H., white, female, aged nineteen years.

*Past History.*—Had the ordinary diseases of childhood; diphtheria and pneumonia when a child.

*Present Illness.*—About January 15, 1915, she noticed a small lump on the right side of her face. Dr. Love was called in and found a small pustule surrounded by a large area of redness. This was treated in a conservative manner by Dr. Love for four days,

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but noticing a spread of the condition and believing it to be erysipelas, I was called in consultation.

On January 22, 1915, I saw her for the first time. The temperature then was  $103^{\circ}$ ; the right cheek was swollen, red and painful to the touch. There was a marked thickening of the skin, with little fluctuation. The pulse was very rapid. Patient excited. Under local anæsthesia two incisions were made. Only a small amount of pus and some blood discharged. In a few days the swelling had increased until the œdema had closed the eye; the temperature fluctuated between  $100^{\circ}$  and  $105^{\circ}$ . She complained of some chilly sensations; restlessness and irritability were marked; vomiting was a prominent symptom; the discharge of pus was rather free. After a few days the buccal mucosa ulcerated; however, on February 12 she was discharged. The wounds had healed and she was considered in fair shape.

She later complained of pains in her chest, back, thighs and ankles which Dr. Love considered probably of toxic origin. In the meantime she had developed a slight temperature which Dr. Love associated with endocarditis.

On March 19, 1915, I was again called in consultation because of a pain in the left thigh. Examination at that time showed the following: Temperature  $103^{\circ}$ ; pulse 120; left thigh larger than right, particularly at the middle third. Palpation revealed a definite hard mass arising from the shaft of the femur and continuous with it. Pressure over the femur caused pain. An X-ray was taken by Dr. Henriques, who interpreted the picture as acute periostitis. However, as I was convinced that the condition was due to pus within the medullary canal, I operated at Touro, March 22, 1915.

I found a large quantity of new bone surroundingg the shaft at the junction of the middle and upper thirds of the femur; the muscles of the neighborhood were already infected, in fact some of the muscle-tissue was apparently ready to slough off. When the medullary canal was opened a large quantity of free pus was found. Cultures were made and Dr. John Lanford reported a pure culture of *staphylococcus aureus*. A large opening was left in the medulla after apparently all of the necrotic bone and breaking down marrow had been removed. A large rubber drain was inserted down to the canal. No packing nor plug was inserted, as I believe that in removing the pack after several days you take along with the gauze the delicate young osteoblasts from the endosteum. Drainage being well established, nothing more seemed indicated. A body cast was applied including thigh and leg.

After the operation the pain disappeared, but the pulse and temperature did not drop. On March 29, the temperature dropped



to normal and remained at that level until April 11, 1915. In fact the temperature did not rise above 100 again until April 25. All the while there was a profuse discharge from the wound, and on May 3 a second radiograph confirmed the opinion that there had been an extension of the disease. We operated again. This time practically the entire medullary canal was laid open, and left open; in order to keep it open I left in a gauze pack. For two days following operation she vomited frequently, and since the pulse was already weak, I felt that fluids must be supplied. We, therefore, gave glucose 4 per cent. drips. During 72 hours, 14 pints of 4 per cent. glucose were given, after which a specimen of urine showed 1 per cent. sugar in the urine. However, on the previous day after 10 pints of 4 per cent. glucose, no sugar was found.

May 7, four and a half days after the operation, she again started vomiting, now only after nourishment—no vomiting at night. Urine shows no sugar.

May 9, six days after operation, nourishment by mouth discontinued. No vomiting.

May 10, nourished well; no vomiting.

During the night of May 11 she again began vomiting after taking fluids. The bowels had acted well every day.

From May 7 to May 12 the temperature was practically normal. On May 12 a new plaster cast was applied and the wound dressed. After returning to her room she began vomiting large quantities of dark-brown fluid. She was unable to retain anything.

On May 14 at 4 P.M., her temperature was 98.6°, pulse 90, respiration 28. At 7.30 P.M., the same day, her temperature was 101.8°; pulse 150; respiration 26.

The stomach tube was introduced and 52 ounces of green fluid was siphoned. The patient's appearance had entirely changed. She was cold and clammy; the face bore the expression of anxiety, the pulse was hardly perceptible at times. Hypodermoclysis was started as well as the free use of hypodermic stimulation (strychnine, morphine, digalen and caffeine, alternately). During the night she was delirious: she did not vomit during the rest of the night. A total of 1900 c.c. of saline solution was given from 10.15 P.M. to 7 A.M., during which time the pulse picked up in volume and the rate diminished until it was 112 at 7 A.M.

On May 15 there was no vomiting, the hypodermoclysis, however, was kept up. The urine at this time showed a trace of albumen, hyaline and granular casts, and red blood-cells.

May 16, vomiting. Stomach emptied and washed. At this time it was noticed that the abdomen was distended, particularly in the upper segments, and the greatest prominence was to the left of and below the umbilicus. When the stomach would be

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emptied the distention would disappear as well as the prominence to the left of the umbilicus. The largest quantity that was siphoned off at any one time was *seven* pints. This contained blood and bile. During the three days, May 15 to 18, hypodermoclysis was kept up continuously, but in spite of all effort the stomach would fill up and the patient succumbed on March 18.

*Autopsy* (Dr. Lanford).—The peritoneal cavity was found free from fluid or any evidence of acute inflammatory processes; the omentum free but rather short; the stomach was enormously dilated and extended from the diaphragm into the pelvis. It was filled with fluid and gaseous material. The intestines were also somewhat distended. The lesser peritoneal cavity was negative. Appendix was negative.

The liver was smooth and of a dark brownish-red color. It was quite congested. The spleen was considerably larger than normal, of a dark brownish-red color, soft and pulpy in consistency. It was covered with a few organized adhesions. The pancreas and adrenals were negative. The kidneys were somewhat swollen and markedly congested. The cut surface showed evidence of increased pressure and was of a dark reddish-brown color, there being but little contrast between the two parts. It bled rather freely on sectioning.

The pelvic organs were negative.

Cases of acute dilatation of the stomach in association with operations on the extremities immediately invite attention to their etiologic factors. Why should a complication of an organ so far removed from the site of the operation arise? The situation seems still further to be complicated when we realize that the same train of symptoms arise in patients who have been previously healthy, in the course of disease such as pneumonia, typhoid and scarlet fever, after a severe trauma, which may or may not cause a fracture, after delivery as well as after intra-abdominal operations. Strange as it may seem, only a few cases have followed operations on the stomach itself. Borchgrevink (1913) was only able to find six cases where an operation had been done on the stomach itself. The above facts suggest certain questions: (1) Is there a common etiologic factor present in all cases—a disturbance of innervation, or is there a constant mechanical condition present? (2) If the constant etiologic factor is not a disturbance of innervation, how do the several distinct exciting causes produce the condition which in turn produces the symptoms of acute dilatation of the stomach? (3) Do we always have evidence of a mechanical factor at autopsy? (4) Are we dealing with several distinct entities which give rise to the same symptoms?

To answer these questions one had best turn to the literature to see what has been done to solve the problem. Here one meets with a series of contradictory statements, some based on (1) experimental

evidence, others on (2) suppositions, and (3) some on the finding at section of the abdomen during life or autopsy.

The autopsy findings in these cases have had only one *constant* feature—the *dilatation of the stomach*—as is illustrated by the following quotations:

"The autopsy on Fagge's now celebrated case showed that 'the coils of all intestine were without exception contracted rather than dilated.' Jessop (*Lancet*, 1888) found the 'stomach, *duodenum* and first six inches of the jejunum were enormously distended, the rest of the bowels being collapsed and small.' Nothing else was found. Hood found a like state of affairs. H. Campbell Thomson, whose monograph on this subject stands out as a classic, after collecting 44 cases from the literature and adding 5 of his own, says, 'In the majority of cases there are no signs whatever after death of any obstruction of the pylorus or intestines below.' The appearance of the intestines varies. In a large number of cases either a part or the whole of the duodenum shares in the dilatation, in several cases dilatation has been noted as stopping short at the point where the superior mesenteric artery comes into relation with the bowels. 'Usually with the exception of the duodenum the coils of intestine appear flattened and collapsed.'

"Stewart (*Lancet*, 1903), 'The stomach was found to have a capacity of 10½ pints. There was no evidence of stenosis anywhere.'

"Box and Wallace found 'The stomach and part of the duodenum dilated.' 'The dilatation extended to the place where the duodenum came in front of the lumbar spine.' No mention is made of compression by the mesentery or its vessels.

"Appel (1899) found a dilated stomach and collapsed intestine, which was crowded into the pelvis. No stricture was seen at any level.

"Conner (1907), after studying 69 autopsies, states: 'The most noteworthy feature in the post-mortem picture is the enormous size of the stomach.' In one instance it is described as reaching into the true pelvis.

"Definite obstruction at the pylorus was found only three times, once by a tumor (Thomson), in one case it was due to a band of mesentery (Riedel) and once the obstruction resulted from adhesions (Riedel).

"A part or the whole of the duodenum was found dilated in 38 cases (55 per cent.). In 19 of the 38 cases in which the duodenum was dilated the dilatation *stopped abruptly* near the lower end of the duodenum, where it passes behind the root of the mesentery, and definite obstruction existed there by the pinching of the gut between the mesentery and its contained superior mesenteric artery and the aorta and vertebral column behind. In 8 cases there was dilatation of the duodenum *but no compression by the mesenteric artery was noticed*. The small intestine below the duodenum is usually collapsed. Moschowitz noted in an autopsy on his patient that the dilatation of the duodenum 'ended abruptly at the point where the superior mesenteric artery crossed the duodenum, the artery standing out like a whip-cord. Below this point the small intestines were collapsed.'"

In many of the autopsy records which were reviewed by Laffer and Conner no mention was made of the condition of the small intestine.



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Many theories have been advanced and some experimental work has been done to prove each. The principal theories that have been advanced have been the following:

- (1) A primary paralysis of the stomach.
- (2) Mechanical obstruction by the mesentery and mesenteric vessels.

In support of each we have many authorities. Brinton in 1859 first offered the theory of primary paralysis of the stomach, and later it was emphasized in the work of Braun and Seidel, Goodhart, Thomson and others. In 1887 Hunter, of New York, stated, "The cause of this condition is very obscure."

The mechanical obstruction by the mesentery and the mesenteric artery presupposes a collapse of the small intestine and its gravitation into the pelvis, thus dragging on the mesentery, which causes the superior mesenteric artery to act as a constricting band, thus obstructing the lumen of the duodenum. Kundrat (1895) is credited with having been the first to describe an incarceration of the duodenum between the mesenteric artery and the vertebral column as an autopsy finding in three cases of acute dilatation of the stomach.

This theory is supported by Albrecht and, as we shall see, by many others. Thomson says, "Albrecht describes how in the dead body the possibility of the superior mesenteric artery acting as a constricting band may be easily demonstrated by putting a finger in the intestine and then pulling on the mesentery, and he also describes how the same effect may be produced by stretching the mesentery by means of a small weight." "I have been satisfied myself that it is possible to produce an obstruction in this way after death, but *I do not feel at all sure that the conditions liable for its production are likely to exist very often during life*" (Thomson). "In the first place it requires a considerable amount of force to produce obstruction in this way. Second, the intestines are not always contained in the pelvis or other situation in which they are likely to cause traction. Third, against the view that constriction occurs through the medium of the superior mesenteric artery is the fact that the position of the apparent obstruction, shown by the dilatation terminating abruptly, is not a constant one."

In 1900 Byron Robinson, of Chicago, "without knowledge of the literature" and after a study on the cadaver, lasting from 1893 to 1900, of the manner in which the transverse segment of the duodenum was compressed by the superior mesenteric artery, nerve and vein, states, "that when the coils of the enteron lie in the pelvis the superior mesenteric artery, vein and nerve compress the transverse segment of

the duodenum in such a manner that gastroduodenal dilatation begins in the transverse segment immediately on the right side of the superior mesenteric vessels and nerve." "I have observed this so frequently," he says, "in autopsies that I know it to be an important factor in gastroduodenal dilatation in persons suffering from ptosis."

Thomson in 1900, after collecting 44 cases from the literature, states, "The immediate cause of acute dilatation of the stomach probably depends upon *some disturbance of the nervous system which gives rise to paralysis* of the muscular walls and which also frequently causes excessive secretion into the stomach cavity."

In 1902, Thomson cited a case in which eight feet of the intestine was dilated, as evidence against the obstruction by the mesenteric vessel theory, and he said at that time, "While in no way denying that some cases may be obstructive in origin, I am *inclined to believe that a primary paralysis of the organ must be regarded as the underlying cause* in the majority of cases."

Thomson says, "Goodhart brought forward notes of all cases of dilated stomach not due to pyloric obstruction in the post-mortem room of Guy's Hospital from 1875 to 1882, and, in the light of general information obtained from these, Goodhart concluded that *paralysis of the viscus is*, if not the determining cause, at *any rate an accompanying condition*."

Box and Wallace (1901) expressed the opinion that the "condition is due to, first, a paralytic condition of the viscus which leads to distention and then, at a certain stage, the distended stomach actually produces obstruction by pressing on the duodenum on the front and to the left of the spinal column." This conclusion is supported by their experiments on the cadaver. "We have found," they say, "by actual experiments on the cadaver that the stomach can be enormously distended by water pressure, with the jejunum cut right across and lying patent in the abdomen. Moreover, the stomach remains distended. *The same result can be attained after the superior mesenteric vessels and peritoneal folds in their neighborhood have been divided. If the stomach to the left of the median line be gently raised the distention of the stomach cannot be produced.*"

MacEvitt, of New York (1906), believes that "whatever the cause may be there is a paralytic dilatation underlying it, caused by some agent acting upon the central nervous system."

Conner (1907) says, "It seems to have been clearly demonstrated within the last few years that a very important cause, perhaps the most

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important single cause, of such stomach dilatations is the sudden incarceration of the lower end of the duodenum between the root of the mesentery which passes in front of it and the vertebral column behind." Despite this assertion his own collected material showed such a condition in only 55 per cent. of the cases.

Laffer (1907), after studying 217 cases, concluded as follows: "The pathology and *modus operandi* of acute dilatation of the stomach and gastromesenteric ileus is not definitely known, but the experimental, clinical and pathological evidence points to a primary innervation disturbance, affecting the gastric nerves or their centres in the brain or cord." *It has not been proven that the compression of the duodenum by the root of the mesentery is the primary cause of the so-called arteriomesenteric ileus. Only 27 of Laffer's cases showed compression by the mesentery.*

H. B. Smith (1907), after a study of six personal cases, all abdominal, says the "evidence is against a mechanical process as a primary causative factor." "The weight of evidence favors a primary gastro-intestinal paralysis, manifesting itself most severely in the stomach on account of the anatomical relations of that organ. The paralysis may be central or peripheral, or both." Mesenteric compression if present is secondary.

McWilliams says (1908), "Evidence is strongly in favor of acute dilatation of the stomach being primarily an innervation disturbance."

J. M. T. Finney (1907) summarized the situation well when he says, "That the obstruction produced by a tense mesentery and superior mesenteric vessels is one cause of acute dilatation of the stomach, will, I think, be generally admitted, but that it is the sole etiologic cause or even the primary factor in its production has not been established."

In my case, as there was no evidence of mesenteric obstruction and as the preponderant evidence points to a primary innervation disturbance, it may be well to inquire how this could account for everything. We have a condition analogous to a dilatation of the stomach without obstruction in dynamic ileus. This analogy has been previously pointed out by Borchgrevink. According to Cannon and Murphy, "Dynamic ileus occurs whenever the intestines become paralyzed, parietic or spastically stenosed." "Is the location of dynamic ileus central or peripheral?" "In dynamic ileus we are dealing with a failure of normal peristalsis. The alimentary canal can perform its motor functions for some weeks almost normally when wholly disconnected from the nervous system, yet according to Magnus, all spontaneous and reflex movements cease when Auerbach's plexus is removed. Con-

sequently, anything which would injure this mesenteric plexus would necessarily result in a cessation of peristalsis."

It seems fairly certain now that the splanchnic nerves, acting through the sympathetic, are purely inhibitory nerves for the intestine. "Strong impulses through the splanchnic nerves, therefore, may be regarded as another cause of gastric and intestinal inactivity."

The stomach derives its nerve supply from the vagi and the splanchnic nerves. Stimulation of the vagi gives rise to peristaltic movements, while the stimulation of the splanchnic nerves brings the movement to a standstill. It has been shown experimentally by Carrion and Hallion "that section of the pneumogastric nerves in the dog leads to dilatation of the stomach and part of the œsophagus."

Thomson further says, "The nervous connections between the vagi and the abdominal plexus are very complex and it is not impossible that the paralysis which involves the stomach may also extend a variable distance along the intestine." Another fact of importance which has been suggested by Thomson is that "once distention has taken place many secondary conditions can arise. The pressure on the surrounding viscera is very great and secondary obstruction of the bowel might be produced without much difficulty."

In order not to unduly prolong this discussion it may be well to state some facts in summary:

- (1) The nerve supply of the stomach and intestines is intimately connected.
- (2) The inhibitor nerve supply of the stomach and intestine is identical—the splanchnic.
- (3) Strong impulses applied to the splanchnics cause a cessation of peristalsis.
- (4) Whether these impulses be the result of trauma, infection or what not, the effect here, as in shock, is the same—an acute dilatation of the stomach, with or without dilatation of the duodenum and, in some instances, part of the jejunum.
- (5) Obstruction by the mesentery and its vessels is not present in over 50 per cent. of cases.
- (6) For the above reasons it seems most plausible that we are dealing with a disturbance of innervation, rather than a mechanical obstruction due to compression by the mesentery and its vessels.

#### BIBLIOGRAPHY

- Conner: American Journal of Medical Sciences, 1907, vol. cxxxiii.  
Box and Wallace: Lancet, 1901, vol. ii, 1259.  
Brown, W. H.: Lancet, 1899, vol. ii, 1017; 1890, April 19.



# ACUTE DILATATION OF THE STOMACH

- Hood: *Lancet*, 1891, vol. ii, 1389.  
 Jessop: *Lancet*, 1888, vol. i, 726.  
 Box: *Lancet*, 1908, vol. i, June 4.  
 Stewart: *Lancet*, 1903, vol. i.  
 Turner: *Lancet*, 1905, vol. i, 292.  
 Thomson, Campbell: *Lancet*, 1902, p. 287.  
 Herrick: *Journal American Medical Association*, 1906, March 31.  
 MacEvitt: *New York State Journal*, 1906, vol. vi, 284.  
 Mayo: *Journal American Medical Association*, 1905, xlv, 1211.  
 Ochsner, A. J.: *American Journal Medical Sciences*, 1906, cxxxii.  
 Appel: *Philadelphia Medical Journal*, 1899, August 12.  
 Bloodgood: *ANNALS OF SURGERY*, 1907, vol. ii, 736.  
 Transactions Association of American Physicians, 1906, vol. xxi, p. 601.  
 Torbert, J. R.: *Boston Medical Journal*, 1909, clxi, p. 217.  
 Smith: *Boston Medical Journal*, 1909, vol. clxi, 529.  
 Sherwood: *Long Island Medical Journal*, 1910, iv, p. 22.  
 Seelig: *Interstate Medical Journal*, 1907, xiv, 517.  
 Root: *Denver Medical Times*, 1907, xxvii, p. 231.  
 Polak: *New York Medical Journal*, 1909, lxxxix, 1184.  
 Miller, C. J.: *New Orleans Medical and Surgical Journal*, 1907-1908, lxi, 629.  
 Heppertin: *Western Medical Review*, Omaha, 1911, xvi, 21.  
 Halsted, A. E.: *ANNALS OF SURGERY*, 1906, xliii, 469.  
 Grandin: *American Journal of Obstetrics*, 1909, lix, 1037.  
 Gibson, C. L.: *St. Luke's Hospital, Medical and Surgical Reports*, London, 1908, i, 80.  
 Ferguson: *American Journal Obstetrics*, 1902, xlvi, 247.  
 Thomson: *Diseases of the Stomach*, 1900.  
 Bettmann: *Lancet Clinic*, 1897, xxxviii.  
 Fagge: *Guy's Hospital Reports*, 1873.  
 Robson and Moynihan: *Diseases of the Stomach*, 1901.  
 Wright: *Practitioner*, 1897, vol. vi, 598.  
 Eichberg: *Lancet Clinic*, 1900, vol. xlv, 8.  
 Robinson: *Lancet Clinic*, December, 1900, p. 577; *Boston Medical Journal*, vol. clv, p. 107.  
 Bellion: *British Medical Journal*, 1903, vol. i, p. 74.  
 Cooper: *British Medical Journal*, 1903, vol. — 910.  
 Campbell: *British Medical Journal*, 1902, vol. i, 324.  
 Broadbent: *Practitioner*, 1898.  
 Weber: *Lancet Clinic*, June 4, 1898.  
 Seelig: *International Medical Journal*, 1907, p. 517.  
 Finney: *Boston Medical Journal*, August, 1906.  
 Halsted: *Journal Surgery, Gynecology and Obstetrics*, 1906, vol. ii, p. 13.  
 McWilliams, C. A.: *Journal Surgery, Gynecology and Obstetrics*, 1908, vol. vii, 294.  
 Codman: *Boston Medical Journal*, 1908, p. 503.  
 Houston: *American Medical Association*, 1908, vol. ii, 1424.  
 Moorhead: *American Medical Association*, 1909, vol. i, 1896.  
 Laffer: *ANNALS OF SURGERY*, March, 1908.  
 Coates: *Lancet*, 1900, vol. ii.

ISIDORE COHN

- Thomson: Lancet, 1901, vol. ii, p. 1113.  
Albutt: Lancet, 1902, vol. ii, 323.  
Halsted: Johns Hopkins Bulletin, 1900.  
Hunter: Boston Medical Journal, 1887, vol. cxvii, 1881.  
Streit: American Journal of Medical Sciences.  
Patterson: Journal American Medical Association, vol. xlv.  
Fairchild: New York Medical Journal, 1909, lxxxix, 801.  
Eskridge: Texas State Journal of Medicine, 1908, iv, 316.  
Blain: Journal Michigan Medical Society.  
Kemp: Medical News, New York, 1904, lxxxv, 249.  
Cannon, W. B., and Murphy: Journal American Medical Association, 1907,  
vol. xlv.  
Lenender: Journal American Medical Association, 1907, vol. xlv.  
Munro, J. C.: Journal American Medical Association, 1907, vol. xlv.

## REVERSAL OF THE CIRCULATION IN THE LOWER EXTREMITY

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THE therapeutic value of attempts to reverse the circulation in the extremities has been freely discussed since this work was first brought to the attention of surgeons by the experiments of Carrel. Carrel and Guthrie in a paper in *ANNALS OF SURGERY* for February, 1906, reached the following conclusions as the result of two experiments: "(a) The valves prevent, at first, the reversion of the circulation in the veins. (b) After a short time, the valves gradually give way and the red blood flows through the veins as far as the capillaries. (c) Finally it passes through the capillaries and the arteries are filled with dark blood. Probably dark blood also returns from the capillaries towards the heart through some veins. (d) Practically complete reversal of the circulation is established about three hours after the operation."

In the fall and winter of 1914, I undertook a series of experiments on animals to determine if possible whether the arterial blood when switched from artery to vein reached the ultimate capillaries of the foot. This was done by severing the femoral artery and the femoral vein, in a dog, below Poupart's ligament and uniting the cardiac end of the artery to the distal end of the vein by end-to-end suture. The other ends of the artery and vein were ligated. The technic of suture employed is described in *Surgery, Gynecology and Obstetrics*, for May, 1914, and more fully in *Surgery of the Blood-vessels*, published by the C. V. Mosby Company, St. Louis, Missouri, 1915. The animals were killed at periods of time varying from a half hour to forty-six days after operation, and a cinnabar mass was injected into the reversed circulation just above the anastomosis. An X-ray photograph was taken and then a bismuth mass was injected into the abdominal aorta, after which another röntgenogram was taken including both hind extremities. The specimens were dissected by Dr. R. H. Whitehead, professor of anatomy in the University of Virginia, who found the dissections corresponded on the whole fairly accurately with the X-ray findings. Our experiments were published in the *Journal of the American Medical Association* for March 13, 1915. Dr. De Witt Stetten, of New York, worked on the same problem, using limbs that had been

amputated for affections in which reversal of the circulation has formerly been recommended. In his excellent article (*Surgery, Gynecology and Obstetrics*, April, 1915) which goes very fully and carefully into the literature of the subject, he arrived at the same conclusions to which our experimental work had led us.

Since then I have had one other animal in which reversal of the circulation was done in the left hind extremity, and the dog killed after sixty-nine days, which is twenty-three days longer than the oldest experiment in our former series. The findings substantiate the conclusions we had formed. The cardiac end of the femoral artery was united to the distal end of the femoral vein about two and one-half inches below Poupart's ligament. Sixty-nine days after operation the dog was killed under ether, the carotid being allowed to bleed while salt solution was being injected into the external jugular vein. A cinnabar and bismuth mass was then injected into the femoral artery about an inch above the point of anastomosis. The artery was tied and röntgenograms were taken. The systemic arterial circulation was then injected through the carotid with bismuth mass and a röntgenogram taken.

In the earlier series we sometimes did not secure satisfactory results, because the mixture was too weak in bismuth or gelatin or because the vessels were left untied. It is important to have a 10 per cent. gelatin solution and as much bismuth as will permit the hot gelatin solution to flow freely. It should, of course, be injected hot. Both ends of the femoral should be ligated immediately after injection, and, if the dog is bled to death and the external jugular vein is opened in the neck, the vein should be ligated before the injection is begun; else much of the mass that is injected in the reversed circulation will flow freely out of the external jugular. The second injection mass should be given through the carotid in the neck instead of the abdominal aorta, as was done in our first series.

The first picture shows a reversed circulation injected half an hour after operation. It will be seen that there is a tendency for the mass to return in the general direction of the branches of the internal iliac vein. The systemic injection (Fig. 2) shows that the collateral circulation is ample to carry the mass into the foot and to fill the saphenous artery of the dog even a half hour after the main trunk of the femoral has been severed. Fig. 3 shows the reversed circulation sixty-nine days after operation, with the mass returning through the large channels into the iliac veins and the vena cava. It will be noted that the mass stops abruptly below the knee. Fig. 4 shows the vena cava containing most





FIG. 1.—Cinnabar mass injected into the reversed circulation, half hour after operation. The X-ray shows that the mass goes only a little below the knee and returns in the back part of the thigh toward the branches of the internal iliac vein. Only a short stub of the artery is shown, as the ligature was tied just above the point of anastomosis. There is, however, very slight, if any, diminution in the calibre of the artery at the point of union.



FIG. 2.—Both hind extremities of the dog shown in Fig. 1 after injection of bismuth mass through the abdominal aorta. Note the excellent circulation in the leg by collateral arterial branches only a half hour after the main trunk of the femoral had been put out of commission.

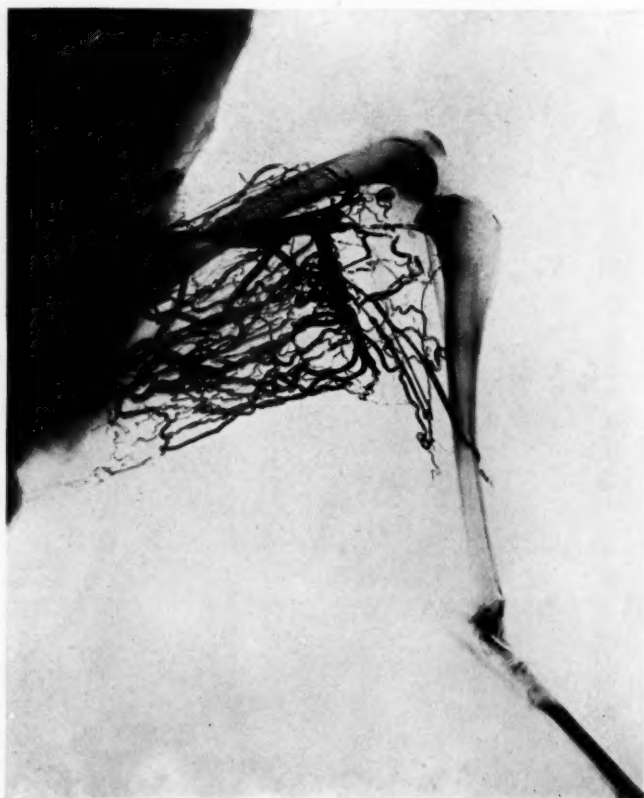


FIG. 3.—Cinnabar and bismuth mass injected into the reversed circulation of a hind extremity of a dog sixty-nine days after reversal of circulation. The exposure is short, permitting the bone and the small branches to be well shown. Note the abrupt termination of the circulation about half-way between the knee and ankle and the large anastomotic channels running back to the branches of the iliac vein.

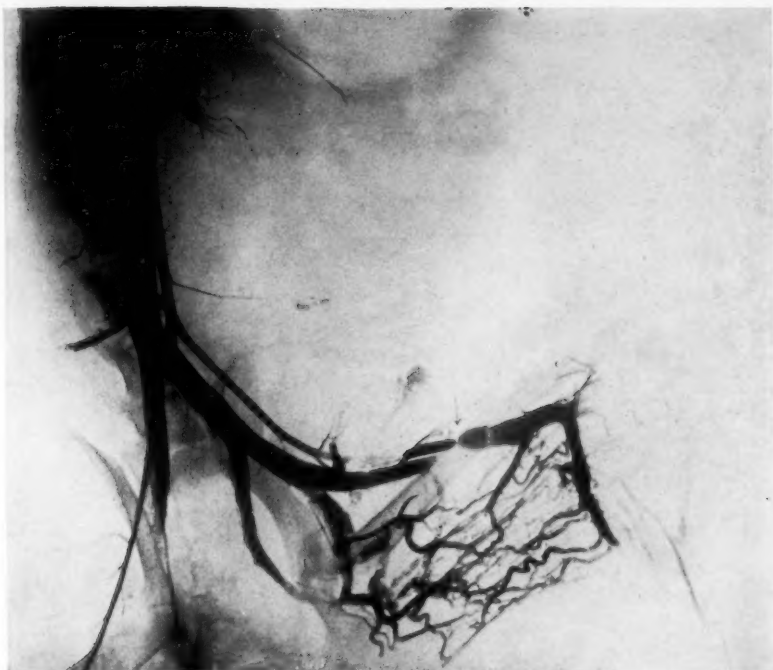


FIG. 4.—The same dog as in Fig. 3. The exposure is longer, obliterating the finer vessels and bone, but shows the iliac veins and vena cava fully distended with the mass that was injected into the reversed circulation. Note also the constriction at the junction of the artery and vein, indicated by an arrow, as compared with the large opening in Fig. 1, a half hour after operation.



FIG. 5.—The same dog as shown in two preceding figures after the systemic arterial system had been injected with bismuth mass through the carotid. Note the excellent arterial circulation in the foot. The black shadow of the body is probably due to a rupture of some abdominal vessel toward the end of this injection, which filled the peritoneal cavity with the bismuth mass.

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of the mass injected into the reversed circulation. Fig. 5 shows the systemic arterial circulation injected from the carotid after the reversed circulation had been injected.

Evidently what happens is that the large valves are first quickly broken down. The arterial blood in the reversed vein then rushes into smaller veins. The smaller valves in the small veins require relatively more force to overcome them than the larger valves in the large veins, because of the relation of cubical contents to square surface. The experiments show that the circulation went but little further down the leg in this dog sixty-nine days after operation than it did in the dog that was injected the first half hour after the circulation was reversed. This seems to show that the valves which are not broken down in the first few minutes will probably hold permanently. Collateral circulation quickly increases, and large veins are formed which readily carry off the reversed blood to the branches of the iliac veins. In this way the pressure upon the obstructing valves is reduced and probably some thickening of these valves occurs. Instead, then, of constant pounding of the heart tending to break down these valves, it seems to do just the opposite. Valves that are not overcome within the first few minutes have less and less pressure upon them until the collateral circulation develops to its maximum. Another interesting point is the tendency of the communication between the artery and vein to close, as shown in Figs. 4 and 5, whereas in a section of a vein transplanted between the ends of an artery this tendency to contraction does not seem to exist.

The beneficial results that are obtained from the reversal of the circulation in threatened gangrene are clearly due to the fact that obstruction of the venous circulation causes the arterial blood to remain in the tissues longer than it otherwise would. The same result can be obtained more accurately and with less danger by ligation of the femoral vein under a local anæsthetic. This procedure has been carried out by von Oppel, Coenen, Lilienthal and others.

## THE CONSERVATIVE TREATMENT OF GANGRENE OF THE EXTREMITIES DUE TO THROMBO-ANGIITIS OBLITERANS \*

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TWENTY-FIVE years ago, in the spring of 1890, I had under treatment in the wards of the German Hospital, a patient, a tailor, in the early thirties, with thrombo-angiitis obliterans of the right lower extremity. There was no pulse in the anterior and posterior tibial arteries, nor in the popliteal. Gangrene of several toes had set in. The persistent severe pain, increasing during the night, could not be controlled. The proposed amputation of the thigh was at once accepted and done. The severe pain promptly disappeared. He could sleep again, and recovered without interruption. About six months later the identical phenomena were noticed on the opposite side. The principal subjective symptom, found in almost all of these cases, the constant severe pain, again proved obstinate. Hypodermic and internal medication of all kinds were tried without giving relief. The patient reëntered the German Hospital for the express purpose of having the second thigh amputated. He begged for it, and I, not knowing of anything else to relieve his suffering, gave in. This case made a deep impression upon me at the time, and has always remained in my memory. I could never forget the sad picture of the poor fellow going home in that crippled condition. From that time on I have followed with keenest interest every new development in the pathological anatomy and therapeutics of this tormenting, terrible affection.

It was but natural that the therapy of this chapter should turn toward conservatism in its further evolution. There is no surgeon alive who would not willingly try anything and everything that offered a fair chance of saving the limb without endangering the life of the patient.

In 1893 Bier's treatment was introduced. Artificial hyperæmia by means of superheated air—baking—was given a careful test by me in cases of gangrene of the toes and other portions of the foot, due to thrombo-angiitis, but proved of little benefit. Now and then the con-

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\* Read in part before the New York Surgical Society, May 12, 1915. Inasmuch as further observations were made since then, the subject was again brought up for discussion before the Section on Surgery of the New York Academy of Medicine, November 5, 1915.

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comitant pains were alleviated and wound conditions improved, but the results were not such as to justify recommendation of Bier's treatment, in any one of its forms of application, as a real help in the therapeusis of this type of gangrene.

Then blood-vessel surgery came in and was taken up with great interest here and abroad: Arteriovenous anastomosis of the femoral and brachial vessels (Wieting) and, later, ligation of the femoral (or brachial) vein in cases of spontaneous gangrene of the extremities (von Oppel). A huge literature has developed on this subject. The gist of it is that both procedures have their failures and their successes. In other words, both are still on trial. To condemn anastomosis on basis of radiographs of limbs the blood-vessels of which had been injected with colored fluid in a reverse direction (Horsley and Whitehead, Stetten)<sup>1</sup> does not appear justifiable. The closing of valves found in these experiments is, no doubt, a correct and indisputable observation. How the closing of these valves could be overcome by the newly established blood current cannot well be imagined. The blood certainly does not circulate through the extremity after the arteriovenous anastomosis has been established in a direction opposite to normal. "Reversal of the circulation" appears, therefore, a term not well chosen, for most likely nothing of the kind occurs. However, what evidently *does* occur after an arteriovenous anastomosis and what I imagine did occur in my case, to be reported below, when the downwardly directed arterial blood stream was being obstructed by the closing of the valves in the femoral vein, is the deflection of this arterial stream into branches of the femoral vein that have no valves; its splitting up into many small streams through thin-walled blood-vessels, that are enlarged *ad maximum* under the high arterial pressure, and the consequent arrival of the arterial blood at the seat of disease in a non-spurting, venously even flow, that continues uninterruptedly. It is but natural that the arterial blood will find its way down to the foot and toes. Wherever no valves are encountered, the stream will flow, driven by the "vis a tergo" derived from the left heart. Of course, some of this blood will run back, by way of collaterals, to the proximal end of the ligated femoral vein,

<sup>1</sup> Horsley and Whitehead injected a hot 10 per cent. solution of cinnabargelatin, by means of the gravity method, into the distal end of the femoral artery, about one inch above the anastomosis previously made. Before the injection the remnant of the blood was leached out with salt solution, the dogs having been bled to death under ether (*Journal Am. Med. Assn.*, March 13, 1915). Stetten selected an emulsion of red oxide of lead in paraffin oil, equal parts. He used the hand syringe for injection of the femoral vein immediately after amputation (*Surg., Gyn. and Obstet.*, April 15, 1915).

and from there to the inferior vena cava and the right heart. However, in spite of this leak, enough blood evidently reaches the periphery of the extremity in favorable cases, to restore the impaired nutrition. The return of the blood occurs, I think, through such branches of the venous system as have not been seized upon by the arterial blood. In other words, I believe that some of the lateral contributing branches of the femoral vein and their subdivisions carry the arterial blood down to the most distant parts of the extremity, and that other parts of the venous system of the extremity allow it to return to the heart.

With reference to the best method of vessel suture I believe that the termino-terminal anastomosis (end-to-end) is preferable to the latero-lateral (side-to-side).

I am, therefore, in agreement with those who maintain that upon the results of color-injections, made as described, no definite conclusions should be based as to the usefulness of arteriovenous anastomosis. Such injections cannot be compared with the physiological circulation of the blood in the living body—the result of the gentle work of the heart, according to the laws of nature, with its 60–70 beats every minute. Here certainly one authentic case of thrombo-angiitis obliterans successfully operated upon by vessel anastomosis and completely restored is of more importance than all adverse reasoning, no matter how clearly presented. And we have many successful cases of this kind.

I could personally present such a patient to-night, a typical case of thrombo-angiitis obliterans with subsequent local gangrene, in the young. Ligature and division of the femoral artery and vein in Scarpa's triangle and end-to-end anastomosis between the proximal stump of the artery and the distal one of the vein cured the patient completely. During the excision of the first metatarsal bone and of the necrosed big toe, that had to be done ten days after the "Wieting" on account of intolerable pain, there was observed by me and those present at the operation, a distinct arterial hemorrhage from the lateral veins of the toe, requiring ligation. There was no spurting; but there was a continuous flow of unmistakably arterial blood from the divided veins on either side of the first metatarsal bone. No better proof than this could be had of the fact that the arterial current, driven by the continuous beating of the heart, had overcome the obstacles in the venous system and then appeared with such force at the most distal end of the foot that the vessels had to be secured. Of course, I am unable to prove that this circulation has continued without obstruction, that not *at present* a thrombosis of the femoral vein is responsible for the excellent condition of the



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extremity and the patient in general, two and a half years after the operation.

If ligation of the femoral vein will usually show satisfactory results, let us then by all means discard the arteriovenous anastomosis and do the ligation, which in its technic is much simpler than the anastomotic operation.

However, as stated above, both operations are still on trial and should be further tested whenever the simpler means in the step-ladder of attempts to save the limb fail.

One of these "simpler means" which really prompted me to write this paper, is to be mentioned now: the methodical hypodermoclysis of saline, or Ringer's solution. Chronologically, it made its appearance after blood-vessel surgery had been taken hold of in connection with the subject in question; clinically, it should take precedence to the former.

In the summer of 1913, shortly after I had done the arteriovenous anastomosis in the case cited above, I chanced to come across the article by G. Koga, of the Surgical Clinic of Professor Ito, of Kyoto, Japan ("Zur Therapie der Spontangangraen an den Extremitäten," *Deutsche Zeitschr. f. Chirurgie*, vol. cxxi, p. 371). The paper gives a brief report of thirteen cases of thrombo-angiitis obliterans in younger patients, every one of whom was benefited by these hypodermoclyses.

Explaining the action of the injections, Koga thinks that they change the viscosity of the blood. In other words and plain language: thick blood is made thin. I have had some correspondence with Professor Ito, a gentleman of great learning, whom I had the pleasure of meeting here in New York ten years ago, regarding this interesting question of blood viscosity. I have also had frequent discussions on the subject with Dr. A. L. Garbat, the serologist of the German Hospital. He, in turn, consulted Professor Burton Opitz, of Columbia University, who, as is well known, has done a great deal of experimental work in this chapter. The latter stated that there is as yet no accurate clinical method of viscosity estimation. (In animals, when the blood-vessel can be exposed and opened, accurate findings may be recorded.) The fine differences reported by various observers are most probably inaccuracies caused by mechanical features of the instruments they employed. Only striking differences may be considered, but then these can just as well be determined by comparative estimations of the hæmoglobin and the total number of red blood-cells, variations of which usually go hand-in-hand with variations of the viscosity.

What kind of instrument was employed by our Japanese colleagues is not stated in Koga's article. However, one year before his paper

appeared, an interesting essay on this question was written by T. Mayesima, also an assistant at Professor Ito's Clinic, "Klinische und experimentelle Untersuchungen über die Viskosität des Blutes" (*Mitteilungen aus d. Grenzgebieten, etc.*, vol. xxiv, 3 pages, 413). He used the viscosimeter of Hess,<sup>2</sup> which permits of reading the relative degree of the viscosity of the blood by comparing the quantity of the blood with the quantity of water running through the apparatus within a certain space of time. Koga likely used the same instrument for his tests.

Two of Mayesima's conclusions read:

1. Saline infusions reduce the viscosity of the blood.
2. In spontaneous gangrene of the extremities the viscosity of the blood is more or less increased. If the increased viscosity is reduced by saline infusion, the gangrene is influenced favorably.

As Professor Ito wrote me, it had been on basis of this article that Koga, at his (Professor Ito's) suggestion, tried the hypodermoclysis clinically. Hence, if we want to give a name to the method we shall have to call it "the Mayesima-Koga treatment."

In the course of the last two years systematic hypodermoclysis with Ringer's solution has been tested in my division of the German and Post-Graduate Hospitals, as an adjuvant in the conservative treatment of gangrene of the extremities. I advisedly do not repeat here the more specific wording of the title of this paper, because we have tried to find out the merits and demerits of the injections *in the various types* of gangrene of the extremities, same as we did with the superheated air in previous years.

Before continuing with the main subject under discussion, I should like to make a few remarks on the experience we have had with superheated air and systematic hypodermoclysis in the conservative treatment of other types of gangrene of the extremities:

I. In those acute, rather fulminant cases of gangrene following embolism of the main artery of the extremities, as we see it occur in cases of chronic heart disease, that tend to the formation of fibrinous deposits on the endocardium, which latter then are driven as emboli into the arterial system; and

II. The more subacute and chronic types: Diabetic; angiosclerotic, also called arteriosclerotic or senile; syphilitic; and trophoneurotic or neuropathic gangrene.

*I. Acute Gangrene.*—I have seen five cases of acute gangrene following embolism. Three times the axillary artery was involved, once the femoral and once the descending aorta. Only in two of these cases

<sup>2</sup> Muench. Med. Wochenschr., 1907, Nos. 32 and 45.

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could a treatment of the patient with superheated air be arranged for. In the first case, a female patient, seen very early after the onset, the effect was splendid; not even part of the third phalanx of any finger was lost. In the second case, that of a man with pronounced myo- and endocarditis, whom I was called in to see in about the third week of his severe illness, the treatment also brought great improvement. He lost more or less of the end-phalanges of his fingers, but he recovered and is still alive. I believe that systematic baking, commenced *immediately* after the onset of the symptoms, is the conservative treatment *par excellence* in this affection.

The radical procedure is arteriotomy and removal of the embolus (pulmonary artery—Trendelenburg, 1906; common iliac—Murphy, 1909; aorta abdominalis, Bauer, 1913). However, some of these patients will not be in a condition to stand the strain of such an operation.

*II. Subacute and Chronic Gangrene.*—1. *Diabetic:* Five years ago I could show before the New York Surgical Society and other medical meetings two diabetics whose limbs had been saved from threatening gangrene by the regular use of superheated air, Bier's artificial arterial hyperæmia.<sup>3</sup> Both were over sixty years of age. One showed all the precursors of gangrene, involving the toes of both feet: great subjective pain, icy coldness and deep blue hue of the skin, with the pulse in the dorsalis pedis and posterior tibial absent. Upon our advice he used superheated air faithfully for two to three years. He still has all his toes.

In another patient I had to amputate the thigh for a rapidly advancing gangrene of foot and leg. About a year and a half later, he began to show evidences of beginning gangrene of the opposite foot. He absolutely refused further operative interference. I made him use superheated air for a long time. Gangrene did not develop. He later died of pneumonia. I could cite other cases.

Not long ago De Witt Stetten, of the German Hospital of New York, reviewed the subject.<sup>4</sup> In his article he does not refer to the patients presented by me previously and the efforts I had made to give this conservative method a wider trial. He publishes the histories of seventeen cases.

It is self-understood that baking cannot save the gangrenous limb of every diabetic. The judgment and experience of the trained surgeon must decide whether an attempt at conservatism is still justified, or

<sup>3</sup> ANNALS OF SURGERY, 1910, vol. lii, p. 713.

<sup>4</sup> Jour. Am. Med. Assn., 1913, vol. lx, p. 1126.

whether amputation should be promptly carried out. The chances of benefit from superheated air are certainly greatest in the very beginning of diabetic gangrene, for we must remember that its effect is the re-opening of collapsed capillaries by the creation of sufficient collaterals to carry on nutrition of the threatened parts.

Neither hypodermoclysis nor blood-vessel surgery seems to have any *raison d'être* in this type of gangrene. The latter remark holds good also for:

2. *Angiosclerotic (arteriosclerotic or senile) gangrene*: Last year I tried hypodermoclysis in a man sixty-four years of age, who had had his left thigh amputated for gangrene three years previously. He had neither syphilis nor nerve trouble, but presented a plain case of arteriosclerosis. He came again with painful trouble in the other leg; the toes, particularly the big one, were cold and blue. I tried hypodermoclysis rather as an experiment. His pain was much relieved. Under further continued superheated air treatment, he shed the nails of all five toes and grew healthy nails instead; surely a sign of good circulation in a region farthest away from the heart. However, one year later, his pain returned, and the discoloration of the big toe reappeared. Six months ago the toe was removed, without giving him relief. Four weeks later the leg had to be amputated.

I tried the conservative treatment with hypodermoclysis in another patient with acute senile gangrene; but ascending thrombosis set in, amputation became necessary, and the patient died.

In acute senile gangrene I would not advocate any other treatment than prompt amputation, best above the knee. If the trouble appears *gradually*, superheated air may stave off amputation for a while.

3. *Syphilitic gangrene*: In this class of cases an antispecific régime—salvarsan, mercury and iodates—should be tried in conjunction with basking. We know that arteriosclerosis, particularly in older syphilitic subjects, with gradual occlusion of the affected vessel in consequence of endarteritis syphilitica, is the direct cause of poor nutrition of the peripheral parts of the extremity.

4. *Trophoneurotic (neuropathic) gangrene*: If any chapter of the interesting question of local gangrene deserves further careful investigation as to its etiology, it is the one believed to be due to vasomotor irritation in the cord (Raynaud).<sup>5</sup> Weir Mitchell's erythromelalgia

<sup>5</sup> Last year H. N. Collins, of New York, wrote an excellent collective article on the various types of circulatory disturbances in the extremities. He endeavors to clear up this chapter with reference to symptomatology and pathology. *ANNALS OF SURG.*, vol. lx, p. 742.

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is ascribed to the same cause, but does not produce gangrene. We know that syringomyelia, locomotor ataxia and peripheral neuritis, can produce a trophic ulcer. We are always ready to hold the nervous system responsible when all of the above mentioned causes have to be excluded.

But just here I think further studies are much needed in order to throw more light on the real cause. Personally I should not be surprised, if in cases hard of explanation *an affection of the blood as such* often had to be held responsible for the local condition. I refer particularly to the local gangrene of the extremities with non-disappearance of the pulse in the distal arteries: "with patent arteries." We feel a good pulse in the tibial and peroneal artery; still there is gangrene. The person is young; he has neither diabetes nor syphilis. What wonder that we think the nervous system is to blame. Yet, here systematic hypodermoclysis may bring relief. I was able to show a case of this type before this section two years ago.

The man was thirty years old. A brother of his, also in younger years, had had both lower extremities amputated gradually, feet, legs, thighs, at another hospital; after the last operation he died. My patient had an extremely painful necrotic paronychia of the left big toe. One year before I saw him, the same trouble had existed in the other foot and had taken a long time to heal. The mere touch of the ulcer now caused excruciating pain, and the patient surely did not exaggerate. A neurologist suggested syringomyelia as the cause. Mindful of the sad experience of the other surgeon in his brother's case, I tentatively treated him conservatively. Baking did not reduce the sensitiveness. Having then just read Koga's article, I started methodical hypodermoclysis, after a part of the nail had been removed and the nail bed thoroughly eschared with the actual cautery under general anaesthesia. With the dry dressing not touched for several weeks, the hypodermoclyses were given—this was my first case—commencing with saline, then with Ringer's solution, which latter was much less painful. Imagine my surprise when under this treatment, with the first dressing still in place, the pains which had tormented the patient for months and refused to yield to any medicinal treatment, gradually subsided, and healthy, strong granulations were found when the first change of dressing was made, three weeks after the operation. The wound healed, and the patient could return to his business. Eighteen months later, a paronychia appeared on the second toe of the other foot—originally affected—also some general pains in the extremity. The



same procedure as in the case of the local gangrene of the big toe of the left foot, with a second series of hypodermoclyses, was advised and carried out. The patient still has slight painful sensations off and on in the right foot, but is fully able to attend to his work. (He was presented at the meeting in good condition.)

But now to return to the subject under discussion, the typical thrombo-angiitis obliterans, as we find it in younger patients—men who are not afflicted with either diabetes, syphilis or a chronic disease of the nervous system. Many have suffered for a great number of years, five, ten, fifteen. At last they come to us on account of unbearable pains in one or more extremities, usually the lower one—pains that do not yield to any of the remedies of the pharmacopœia, internally or subcutaneously administered. They show local gangrene of one or more toes or fingers, or a portion of the foot, usually in the presence of a reduced or missing pulse in one or both feeding arteries of the foot or hand, often also of the popliteal.

In the course of the last two years I have had some 30 odd patients of this type under my personal observation and care and have seen at least 12 others through the courtesy of colleagues.

Before discussing the experiences I have had in the treatment of these cases, it seems necessary to first touch upon a few points in their histories.

*Age.*—The patients are usually between thirty and forty years of age; never over fifty.

*Sex.*—Only male patients are subject to this disease. As far as I know, there is not a single case of *typical* thrombo-angiitis obliterans in the female on record. Those female patients who have been pronounced as suffering from the disease present either—according to my belief—another type of gangrene or have to be looked upon as very rare exceptions.

*Nationality.*—The majority of these patients are Hebrew immigrants from Russia, Galicia or Poland. Whether or not their American-born offspring become similarly afflicted needs further observation. Buerger has twice seen the affection in the children of these immigrants (personal communication); I have not seen an instance of that kind. Koga<sup>6</sup> reports the disease among Japanese; Ochsner<sup>7</sup> among Swedes.

*Occupation.*—Many of my patients were tailors or cutters, working in the sweat-shops, often using their feet to run machines. For a while

<sup>6</sup> *Loc. cit.*

<sup>7</sup> Transactions of the Chicago Surgical Society, Surg., Gyn. and Obstetrics, October, 1915, p. 536.

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I thought this kind of work might be a causative factor, but later I found that all sorts of trades contribute to these patients. There were bakers, newsdealers, carpenters, salesmen, etc., so that apparently no specific occupation has any particular bearing on the etiology of the disease. However, a majority of them were tailors or cutters.

*Habits.*—Many of these patients are inveterate smokers. Some told me that they smoked as many as 7 or 8 packs, 70 or 80 cigarettes, per day. All patients observed by me were individuals belonging to the poorer classes, men who live in the tenements. People who live in better surroundings do not seem to become afflicted with this disease.

*Pathological Anatomy.*—Leo Buerger, of New York, has made a series of most painstaking dissections and careful microscopical studies of the blood-vessels of limbs amputated for thrombo-angiitis obliterans. He found the lumen of the vessels, usually the arteries (though the veins may also be involved, 40 per cent.), narrowed or blocked, due to a distinct thrombosis. The thrombosis begins distally and works up. It does not start in the capillaries or arterioles, but in the next higher groups. He further found that the chief thrombus usually occurs in the popliteal rather than in the smaller vessels (D. C. Strauss, of Chicago, has made a similar observation, *Surg., Gyn. and Obstetrics*, October, 1915, p. 536, Transactions of the Chic. Surg. Soc.). Missing pulsation in the peripheral arteries, therefore, does not necessarily imply occlusion of these vessels. They may remain patent, while the thrombus is found higher up.

Buerger believes that he has demonstrated thrombo-angiitis obliterans to be a clinical and pathological entity, "a process in which an acute inflammatory lesion together with occlusive thrombosis of arteries and veins is the characteristic lesion." He is further of the opinion that the histological changes in the veins point to the existence of an infectious process (some microbial agent).<sup>8</sup>

On basis of my clinical observations, I venture to advance a further explanation: It seems to me that a local thrombosis of the smaller arteries, often also of the veins, must not necessarily have been caused solely by the acute inflammatory lesion of the vessel walls; some change or disease of the blood itself may be responsible for its abnormal tendency to coagulate when it flows through vessels of smaller calibre (see below).

*Etiology.*—I. *Infection:* On basis of his histological studies Buer-

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<sup>8</sup> Proceedings of N. Y. Pathol. Soc., N. S., vol. xiv, No. 4, April, 1914; *Surg., Gyn. and Obstetr.*, November, 1914, p. 582-588; *Journal of Med. Research*, vol. xxxi, No. 2, November, 1914.

ger, as stated, advanced the theory that thrombo-angiitis obliterans might be of infectious origin. He has done so much research work in connection with this trouble, that his opinion certainly must carry weight. However, in the face of such a theory, it is hard to understand why the disease is not more general; furthermore, why the female sex should be exempt from the infection.

2. *Food*: One might possibly look for an etiological factor in the food. Yet, this would be hard to explain in view of the fact that only male patients are affected, while practically the same food is partaken of by both sexes.

Ochsner found that his patients ate much salted meat. Under a salt-free diet several improved considerably and in several of them the primary necrotic ulcer healed without an operation. He, therefore, leans toward the explanation that the food plays a rôle in the etiology of the disease.<sup>9</sup> Ito attributes the trouble to the exclusive consumption of vegetables. Many Japanese are vegetarians who, he thinks, develop an insufficient state of nutrition of the walls of the blood-vessels. Wieting expresses the same opinion.

3. *Tobacco*: Some authors incline to the belief that nicotine-poisoning has a great deal to do with the gangrene. As stated above, some of my patients had been smoking 70-80 cigarettes per day. On the other hand, there were just as many who were not addicted to the use of tobacco at all and still showed the same characteristic gangrene. It is a well-known fact that the excessive use of tobacco favors the development of arteriosclerosis; this latter disease, however, has nothing in common with thrombo-angiitis obliterans.

4. *Internal secretion*: Some believe that the disease is due in part to a disturbance in the internal secretions and, therefore, treat these patients empirically with thyroid extract, etc. The fact that women seem to be immune might justify the assumption that something in their system protects them—something that the male sex does not possess. Reflection turns toward the genital sphere. Perhaps the internal secretions from this system, particularly the ovaries, furnish the protection against the effects of the still unknown noxa.

5. *Viscosity of the blood*: Mayesima and Koga hold the degree of the viscosity of the blood responsible for the gangrene. In this connection it is interesting to note that the viscosity in the male is higher than in the female sex.

Further investigation is required to prove this contention, and to find the underlying cause of this difference in the viscosity.

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<sup>9</sup> *Loc. cit.*

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6. *Quality of the blood as such:* It does not seem plausible that the viscosity of the blood alone should be responsible for the trouble. The tendency to recurrence of the symptoms in some cases, after disappearance under the systematic hypodermoclyses, would seem to speak against such an assumption. As I said before, it is my belief that the quality of the blood itself is altered in these cases and plays an important rôle in the development of the thrombosis. An additional inflammatory condition of the smaller blood-vessels, that lead to the local thrombosis (Buerger), does not necessarily have to be present. Observations have shown that gangrene can set in with the tibial arteries patent and pulsating. (See further down.)

### CONSERVATIVE TREATMENT OF THROMBO-ANGIITIS OBLITERANS

1. *Superheated Air.*—So far as the overcoming of pain is concerned, superheated air which is often of such great benefit in diabetic gangrene has, in my own experience, shown no lasting effect upon thrombo-angiitis obliterans. Buerger has seen better results. Dr. H. W. Frauenthal, of this city, states that the heat produced by the white light is more efficient than the ordinary superheated air, as produced by Bier's apparatus.<sup>10</sup> Personally, I have never tried the heat of the white light.

2. *Hypodermoclysis with Ringer's Solution.*—Since the fall of 1913, as mentioned before, I have had some thirty odd of these patients, all of whom were given a series of hypodermoclyses, sometimes repeatedly. Twenty-four injections was the limit we have arbitrarily set down. They were made either every day or every second or third day. One tabloid of Ringer's solution is dissolved in 500 c.c. of *distilled* sterile water. It is absolutely necessary to use distilled sterile water. With ordinary sterilized water we have often seen infiltration and fever to occur. A big long needle has been used. The infraclavicular space, submammary connective tissue and external aspects of the thighs have been the places of application. Starting on one side from above, the opposite side follows in the same sequence, so that every region is subjected to the injections four times. The abdomen and inner aspect of the thighs are less favorable places for this purpose. Local pain and swelling, which easily set in on repeated application at the same place, have been controlled by moist dressings (Priessnitz).

For better observation all these patients were admitted to the ward and remained there until the course of treatment was completed. It is,

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<sup>10</sup> Transactions of the Sixteenth International Med. Congress, Budapest, 2d part, p. 906.

of course, a great burden and, at the same time, hindrance to an active surgical service to have these chronic cases occupy beds in the wards. It is advisable to treat them in the dispensary, at an hour other than the usual visiting time. One assistant or one trusted nurse can do the work. In the spring of this year I saw at the Hospital for Deformities and Joint Diseases twelve patients of this type receive hypodermoclyses at the hands of one nurse, a stand, holding two bottles, being placed between each two tables or stretchers. Afterward the patients were allowed to go home. I myself, too, have treated such patients in an ambulatory fashion and have seen no harm result therefrom. Of course, patients with advanced gangrene need hospital attendance.

The effect of this treatment sometimes was remarkable. Often the principal subjective symptom, the ever-present tormenting pain, ceased as if by magic, usually after the tenth to the fifteenth injection, and without any other internal medication, left out on purpose. Hypodermics of pantopon,  $1/3$  grain for the dose, as obtainable in ampoules, an anodyne from which I have seen now and then some little effect in controlling the pain, could be stopped. Refreshing sleep—not had for weeks or months—returned, and therewith, appetite, gain in weight, and improvement in the nervous state of the patients. In some the pallor of the face gave way to red cheeks, in the absence of any apparent change in the laboratory findings as to the condition of the blood. (Repeatedly I have been surprised to find in these patients besides a low blood-pressure, that the blood examination at the time of admission to the hospital showed a high percentage of hæmoglobin and an almost normal number of red blood-corpuscles; in fact, there was no disturbance in the morphology of the blood picture.) Hand in hand with general improvement went the local. Often the gangrene became localized and healthy granulations sprang up, without previous local cauterization of the old sores. Ulcerations that had been present for months began to heal slowly—seldom quickly. Slow cicatrization was the rule. Return of the pulse in the arteries of the affected limb was seen very rarely.

In some of the patients—the minority—the improvement has been lasting; in most of them the symptoms, particularly the pain, returned after a while, though in milder form. Almost none of the discharged patients could walk for longer distances: after covering a few blocks, pains in the calves of the leg would set in, forcing them to sit down (persistence of claudication). They, therefore, returned to the hospital for a second course of treatment. Again the result often was favorable.

Koga saw improvement in every one of his thirteen cases. While I am not in a position to report such uniformly satisfactory results, I



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am ready to say that this treatment deserves a permanent place among the means employed by us in trying to combat thrombo-angiitis obliterans on a conservative basis.

3. *Arteriovenous Anastomosis or Ligature of the Femoral Vein.*—See above.

I believe it might be a good plan to try additional organotherapy by internal administration in every one of these cases, empirically: first thyroid tablets; then pituitary or thymus; finally also ovarian (oöphorin). If none of these alone does any good, the effect of the combined extracts, as offered of late in the hormotone tablets, might be tried.

In reflecting upon the cause of the beneficial effect of the hypodermoclyses upon these patients, one cannot help but feel, as intimated above, that the repeated hypodermic administration of this solution of important salts, besides reducing the viscosity, exerted a definite beneficial influence upon the blood as such, in other words, that the *quality* of the blood was favorably affected.

Starting from this premise, viz., that *the changed quality* of the blood as such plays an important rôle in the etiology of thrombo-angiitis obliterans, we recently went one step further, and tried: (1) blood transfusion (sodium citrate method); (2) repeated intravenous injection of a 2 per cent. watery solution of sodium citrate. Both might probably be done to advantage after a venesection. But this we have not tried as yet.

The injection of sodium citrate solution was tried tentatively on basis of the fact that it will keep blood in a fluid state for a number of days (Hustin, Weil, Lewisohn). I reasoned that, if sodium citrate will prevent coagulation of blood in a container, it ought to do this also, perhaps even better, in the living body, and that repeated injections of watery solutions of this salt directly into the blood, the viscosity of which had been reduced by the hypodermoclysis of Ringer's solution, might lessen for a longer period its tendency to coagulate. If so, then the transfusion of blood would be rendered unnecessary, and the treatment of these patients infinitely simplified. For, as will be shown further on, it is very difficult to find donors with suitable blood for transfusion in these cases. Besides, the majority of the patients are not at all in need of additional blood, in that they usually have, in spite of prolonged sickness, a high percentage of hæmoglobin and satisfactory count of erythrocytes.

It would lead too far, here, to go into details. I hope that Dr. Garbat, whom I was fortunate enough to interest in this question, and who gave much of his time last summer to a study of important points connected with the subject, will soon publish his personal impressions *in extenso*.

The following remarks, quoted in part from Dr. Garbat's report, must at present suffice:

"1. *Blood Transfusion*.—In the selection of donors we met with certain difficulties. It was most difficult to find suitable persons, as in almost all instances the patients' red blood-cells were easily agglutinated by the donors' serum. Of the four cases of thrombo-angiitis obliterans treated, one belonged to the very rare, so-called fourth group, and the other three all belonged to the so-called rare third group.<sup>11</sup> For one patient it required the examination of 38 donors to find a suitable subject; for another it required the examination of 40 and for a third even of 54 subjects. (But the blood of each of the three, that belonged to the one group, fitted that of the other for transfusion, a condition that was to be expected.)

"In contrast to this type of gangrene, a patient with arteriosclerotic gangrene, who was to be subjected to transfusion, was fitted with four suitable donors out of six examined.

"The fact that three of the above-mentioned patients belonged to one and the same rare group, and the fourth to a still rarer one, may have been a mere coincidence. At the same time, one might set up the

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<sup>11</sup> As is well known from the work of Landsteiner and Shattuck, the serum from one human being may agglutinate the red blood-cells of another human being. This phenomenon is known as iso-agglutination (Ottenberg, *Jour. of Experimental Medicine*, vol. xiii, No. 4, 1911). Many workers at first regarded iso-agglutination as of pathological significance. Halban, Ascoli and others, however, showed that iso-agglutination occurs with a large proportion of normal bloods, and Landsteiner discovered the remarkable fact that all human bloods can be divided into three sharply defined groups, according to the way in which they inter-agglutinate. To these groups was subsequently added a fourth, independently discovered by several observers.

The serum of the first group, known as Group I, possesses the power of agglutinating the red cells of members of the other groups, but the red cells of members of Group I are not agglutinated by any human serum. This group includes about 50 per cent. of all persons who were examined as donors.

The serum of members of the second group (Group II) agglutinates cells of persons belonging to the third and fourth groups, but not of members of Group I. The cells of members of the second group can be agglutinated by sera of individuals of Group I and Group III only.

The third group is reciprocal of the second group. Its serum agglutinates cells of persons belonging to members of the second and fourth groups; its cells are agglutinated by sera of the second and first groups.

The fourth group, also a rare group, is characterized by having no agglutinin for the red blood-cells of any of the former groups, and its cells being agglutinable by the sera of all other groups.

The group characteristics are permanent for each individual throughout his life and, furthermore, are hereditary and follow the Mendelian law.

## GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

hypothesis that people belonging to the rare third and fourth groups are possibly more susceptible to vascular (or blood) diseases, particularly to the condition known as thrombo-angiitis obliterans.

"2. *Repeated Intravenous Injection of a 2 per cent. Watery Solution of Sodium Citrate.*—Four patients received an intravenous infusion with sodium citrate once per week. One got in ten weeks 13 infusions corresponding to 19.5 grammes of sodium citrate; one got in ten weeks 10 infusions corresponding to 12.5 grammes of sodium citrate; one got in ten weeks 9 infusions corresponding to 13 grammes of sodium citrate; one got in ten weeks 8 infusions corresponding to 9 grammes of sodium citrate.

"Under this treatment the patients claimed that their pains became less, but it must be stated that they had already been favorably influenced by the hypodermoclyses with Ringer's solution.

"The objective findings were: (1) that the blood which at first was very thick, so that it flowed with difficulty through the salvarsan needle, later on came out much more easily; here viscosity tests would have been of importance; (2) one man, whose radial pulse had been obliterated, had a return of radial pulsation.

"As to harmful effects from the sodium citrate infusions, there were none."

This treatment seems encouraging, provided the effect is lasting. Otherwise we must strive to find some other chemical, useful for intravenous injection in this class of patients. At all events, the hypodermoclysis with Ringer's solution should be tried first. If 10 to 15 injections do not improve the local and general condition, the intravenous treatment should be added.

It is our intention to analyze also the cerebrospinal fluid of these patients and compare its composition with that of the blood, and, further, to ascertain the amount of their fibrinogenous substance.

We realize that these investigations are still in the embryonic stage. They represent only the very first attempts, but, perhaps, in the right direction.

### CONCLUSIONS

1. In case of typical thrombo-angiitis obliterans, conservative treatment should be resorted to before amputation.

The following sequence might be observed: (1) superheated air; best combined with (2) systematic hypodermoclysis of Ringer's solution. If these simpler conservative means prove of no avail, *conservative operative* measures are indicated, viz., (3) tying of the femoral vein or arteriovenous anastomosis.

Both latter methods should be subjected to further careful clinical research as to their *real* value.

2. Superheated air may bring improvement of the symptoms; however, a *lasting* beneficial effect therefrom has hardly ever been seen. It rarely controls the pain.

3. The systematic hypodermic injection of 400 to 500 c.c. of Ringer's (or of physiologic salt) solution (Mayesima-Koga) daily, or every second or third day, deserves a definite place in the conservative treatment of thrombo-angiitis obliterans. Its effect may be lasting or temporary. If temporary, repetition usually again brings improvement. Two such series of injections represent a sufficient test as to their usefulness.

4. If gangrene has set in, it can, of course, not be made good. What has died, remains dead. But its progress may be stayed by the hypodermoclysis treatment: old and obstinate ulcerations may heal; the otherwise uncontrollable pain can be relieved.

5. Internally, a simultaneous administration of organotherapeutic preparations deserves a careful test.

6. Inflammation of the wall of the blood-vessels of the next higher groups to the capillaries, arterial as well as venous, seems to be responsible for the thrombosis (Buerger). Its cause may be microbic.

However, the increased viscosity of the blood, viz., blood that is thicker than normal, also seems to play an important rôle in the etiology of the disease.

7. It is possible that an altered quality of the blood as such also represents a cause for the occurrence of the thrombosis and subsequent gangrene.

8. On basis of this reasoning, procedures which tend to reduce the coagulability of the blood *within the body* deserve to be tried in our efforts to find the underlying cause of the trouble.

9. Intravenous injections of anticoagulating substances, as, for instance, of a 2 per cent. watery solution of sodium citrate, may prove to be a useful adjuvant to the systematic hypodermic administration of Ringer's solution.

## HYPOPHYSIAL DISORDER IN MAMMARY CANCER AND ITS RELATION TO DIABETES INSIPIDUS\*

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CLINICIANS have known for some time that in cancer of the breast, especially in its last stages, polyuria appears for variable intervals without any recognizable cause. While the etiology of diabetes insipidus was still undetermined, polyuria in these cases was either overlooked, or was supposed to be a renal complication, such patients usually being of an advanced age, in which the kidney may frequently be found shrunken.

Diabetes insipidus has been divided into two groups: (1) The symptomatic, due to some organic brain disease (irritation of medulla, pons or cerebellum); (2) the idiopathic, which appears without any pathologic findings in organs and without any accompanying clinical symptoms.

The first condition has been already proved experimentally by many authors. As is well known, Claude Bernard observed that a transient glycosuria and polyuria could be provoked by puncture at a point in the floor of the fourth ventricle between the origin of the pneumogastric and auditory nerves. Eckardt repeated Bernard's experiment and found that the stimulation of a point just anterior to this so-called sugar centre would occasionally produce transient polyuria only. In addition, there are many clinical observations which favor the cerebral cause of polyuria. Kahler found affections of the infundibulum, substantia perforata posterior, and corpora mammillaria in 7 cases among 27 of diabetes insipidus. Oppenheim observed polyuria in 12 cases among 36 of basal luetic meningitis.

On the other hand, idiopathic diabetes is supposed by many authorities to be due to a disordered function of the kidney, and is not to be confused with polyuria in hysterio-psychopathic patients or that which is provoked by some emotional stress. Meyer thinks the cause of this disease is due to the inability of the kidney to produce urine, which exceeds a certain low grade of concentration. In these cases the lowering of the freezing point of the urine, the index of the concentration, shows little change after salty food. Forsbach and Weber<sup>1</sup>

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\* This material was obtained and studied in the University of Tokyo.



observe, however, that the kidneys of such patients react in certain measure of the urine concentration not only to the supply of sodium chloride and purins, but to drugs which apparently must decrease the diuretic stimulus. As there is no pathologic finding in the kidney in this case, the source of the trouble is still questionable.

With advances in recent research of the internal secretory organs, the hypophysis cerebri has become a focus of investigation. Certain diseases, such as acromegaly, adiposogenital dystrophia, which are very likely to be caused by hypophysial disturbances, are often accompanied by diabetes insipidus. Borchardt reported a case of the hypophysial tumor, with polyuria and without acromegaly. Erdheim<sup>2</sup> observed the polyuria only in basophile adenoma of the hypophysis. Erdheim, Goetzel and von Bartals described the combination of adipositas, atrophy of the genitals, and diabetes insipidus. Later Frank<sup>3</sup> and Cushing<sup>4</sup> associated polyuria with bitemporal heminaopia in lesions of the base of the skull with hypophysial disturbance. Indeed, Frank saw polyuria which was caused by a bullet in the region of the sella turcica. It is, moreover, known experimentally that polyuria is brought about by the extirpation of the hypophysis and almost invariably by resection of its pars posterior (Cushing and Goetsch<sup>5</sup>). Taking the above-mentioned facts into consideration, we must look for the real cause of polyuria in the pituitary body. At first Simmonds<sup>6</sup> published the opinion, that diabetes insipidus in cancer of the breast was caused by metastasis into the hypophysis. His patient, a woman aged thirty-seven years, had her right breast removed for very extensive cancer, and afterwards had a recurrence in the breast and glands of the neck. Polyuria was noted about 8 weeks after the operation, and one month later the patient died. At autopsy the pars posterior of the pituitary body with the sella turcica was found to be completely destroyed by metastatic tumor, the pars anterior and intermedia remaining unchanged. Therefore, Simmonds thought the polyuria must be the result of the pars intermedia having been irritated to hyperfunction by the neighboring destructive process. He reported another case, however, with a different explanation. This patient was a woman forty-six years of age, in whom obstinate polyuria (7 litres daily) appeared nine months after the removal of her breast for cancer. She died three months later. In this case the total neurohypophysis, pars intermedia and pedicle were entirely broken down by the cancerous mass. From these findings, Simmonds did not think it possible that the polyuria was caused by the hypersecretion of the destroyed parts. On the contrary, he believed it the result of the loss of hypophysial

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function. Remembering that in the first case mentioned the pedicle, the probable channel of the hypophysial secretion, was destroyed by the metastatic tumor, he says the new explanation would be equally applicable.

Stimulated by Simmond's researches I investigated 35 hypophyses in cases of mammary cancer which came to autopsy. The original tumors in the breast were in all cases the glandular cell cancer. The pituitary body was divided into two unequal parts in the posterior anterior direction. The smaller part was cut by means of frozen section and stained by Sudan III and paracarmine for the special purpose of investigating the fat particles in the chromophilic cells of the pars anterior. The larger part was fixed by the Formol-Müller method, embedded with paraffin and cut in serial sections. The sections were stained with Delafield's hæmatoxylin and eosin, Van Gieson, and the combined stains of May-Grünwald and Pappenheim.†

By the last method, the nucleus is stained a splendid violet and the eosinophile a beautiful red. In the sections stained, I found two metastases in a series of 35 hypophyses. The histologic findings in the remaining cases were not abnormal, at least not abnormal enough to be worthy of mention. There are no peculiar variations in the different kinds of cells in the pars anterior. Sometimes the eosinophiles are relatively increased, sometimes chromophobes are greater in number. As is well known, the chromophiles, especially the eosinophiles, are in the majority in middle age and continue to increase with the advance of years. Löwenstein states that the chief cells are more numerous in the young than in the old. Thinking of these cells as probable different stages of secretion, no weight is attached to the slight variations of their relative number. Besides the fat metamorphosis of epithelium, the increase of pigment cells in the pars posterior seems to be due in advanced age rather to physiological changes. Benda found severe fatty degeneration of the epithelium in women of seventy-eight years of age, with cancer of the rectum, and thought it a sign of the marantic stage. Next the emigration of epithelial

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† The use of the last stain is somewhat complicated, but advisable for the representation of cells of different kinds in the pars anterior. I shall describe it briefly: (1) The section is in May-Grünwald's stain, 30 minutes in an incubator at 37° C. (2) In diluted Panchrom solution (10 drops in 10 c.c.) stain, 30 minutes (in incubator). (3) Wash quickly in water. (4) Put in 2 per cent. picric acid solution. (5) Wash thoroughly with water. (6) Put in acetate of aluminum. (7) Wash in water then dry on blotting paper. (8) Dip quickly in alcohol and acetone. (9) Put in absolute alcohol until blue color of section becomes faint. (10) Put in cajuput oil and embed in neutral balsam.

cells in the pars posterior and the accumulation of squamous epithelial cells are considered senile signs (Naegeli<sup>7</sup>). First, Thom described such growth of cells of the pars anterior into the pars posterior. Löwenstein thought them chief cells, Erdheim considered them migratory basophilic cells and his opinion was confirmed by Rautman in animals. On the other hand, Tölken<sup>8</sup> described them as the transformed cells of zona intermedia. These migratory cells cannot be confused with metastatic cancer cells, because the shape and size of the former and their nuclei are regular and almost similar, not only to each other but to the cells of the adjacent pars anterior, especially to the basophilic cells. The nucleus does not show karyokinesis nor is there any visible state of destruction or compression on neighboring parts. The accumulation of squamous epithelial cells was noticed first by Erdheim. They are found particularly on the anterior surface of the pars anterior, and more especially in the pedicle up to the infundibulum. The cells show no hornification and are not to be seen in young people. They are the embryologic remnant of the hypophysial duct, and become visible with advancing age. They can easily be distinguished by their localization and character from metastatic tumor cells. The following are brief descriptions of two of the more interesting cases.

CASE I.—H. A., a woman fifty-eight years of age. Simple mammary cancer. Two months after the removal of the right breast cancer recurred in the field of operation and spread to the left breast. The patient died 6 months later. During the last four weeks of her life polyuria associated with moderate polydipsia was present. The amount of urine varied from 5 to 9 litres and was of abnormally low specific gravity (1002–1005). Necropsy showed the wall of the chest, the ribs and several long bones affected with cancerous metastasis. The kidneys were not apparently diseased. No lesion was visible in the brain. The hypophysis cerebri weighed 72 cg. The anteroposterior diameter being 11 mm., transverse 15.5 mm., height 7 mm. Density was somewhat increased. The cut surface of the posterior lobe was gray. Frozen sections stained by Sudan III showed numerous fat particles in the chromophilic cells. In the fixed specimen the pars posterior was found almost completely occupied by a metastatic cancerous mass which extended to the borders of the pars anterior. The pars intermedia had many stiletted lumina filled with colloidal and desquamated cells. Cells of the pars anterior showed no remarkable variation. There was an excessive number of eosinophiles. The pedicle was free from metastasis.

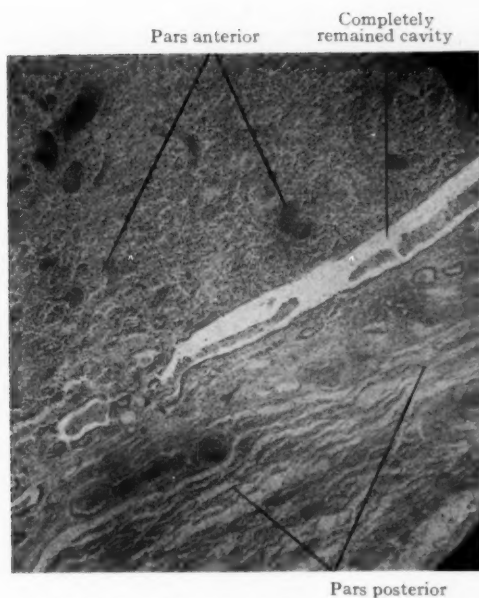


FIG. 1.—Hypophysial cavity in woman fifty-eight years old.

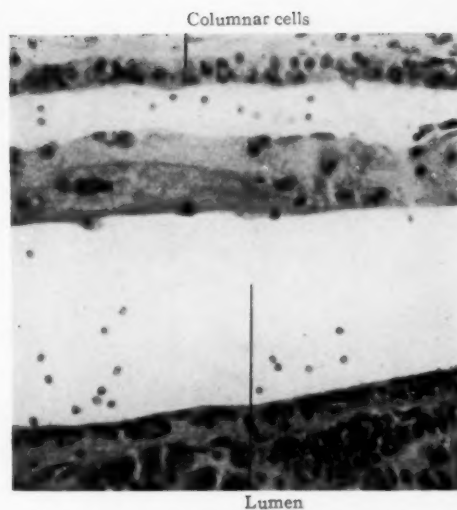


FIG. 2.—Columnar cells of the hypophysial cavity.

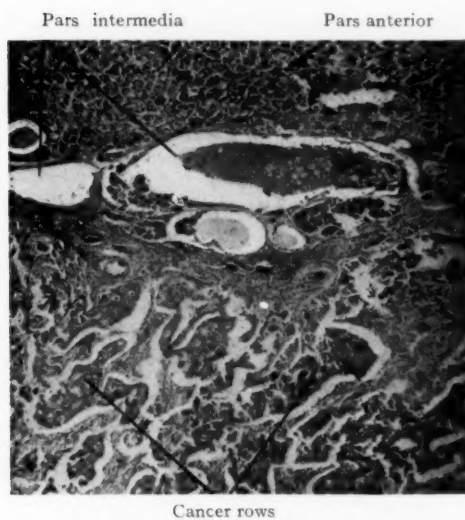


FIG. 3.—Case I. Metastasis of cancer in pars posterior of the hypophysis cerebri.

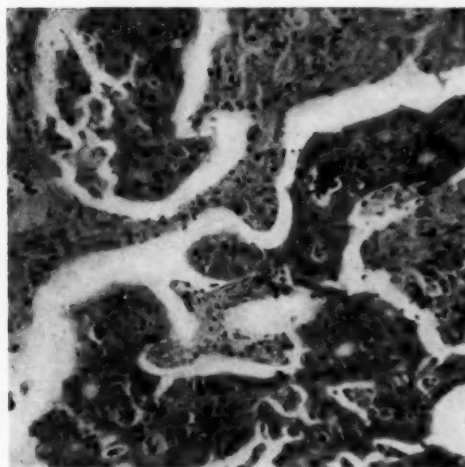
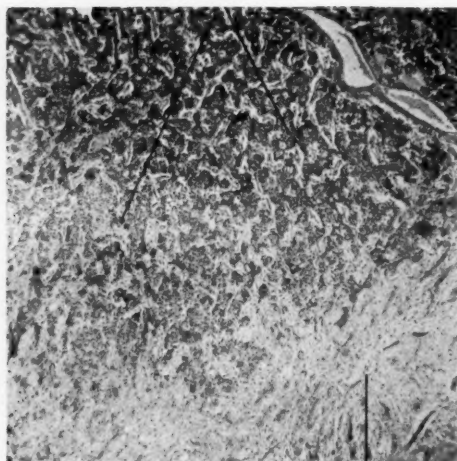


FIG. 4.—Case I. Cancer cells (200 mm.).

Emigrated cells



Pars posterior

FIG. 5.—Emigrated cells from pars anterior into pars posterior.

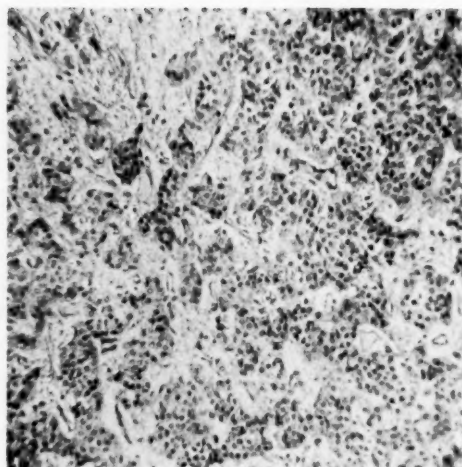


FIG. 6.—Emigrated cells from pars anterior (200 mm.).

Squamous cells

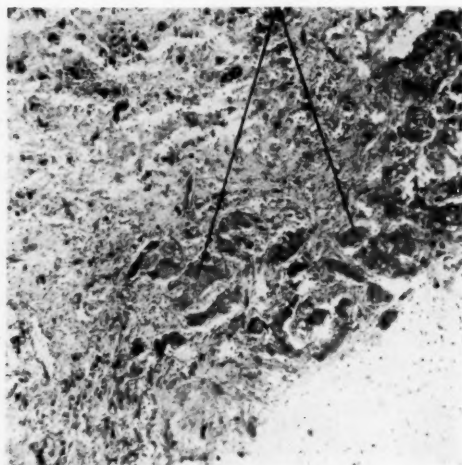


FIG. 7.—The accumulation of squamous epithelial cells.

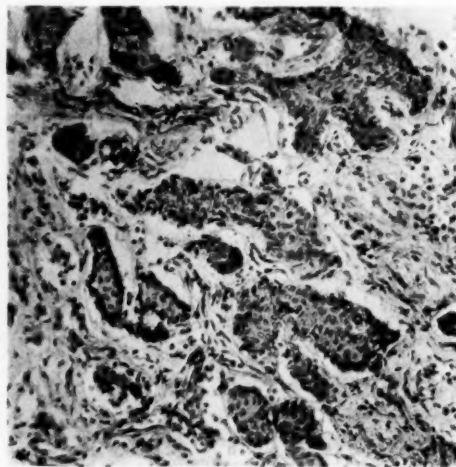


FIG. 8.—Squamous epithelial cells (200 mm.).



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CASE II.—A. L., a woman forty-seven years of age. Right breast removed at operation. Histologic diagnosis was medullary cancer. About 5 months after the operation a metastatic growth appeared in the axilla and the supraclavicular fossa. Seven months after the operation the patient died. Several days before her death the quantity of urine increased 3 to 5 litres a day, with a specific gravity of 1003–1005. Necropsy showed part of the sternum affected by a cancerous mass which had broken into the mediastinum. In the right lung there were several small metastatic areas. The kidneys and brain showed no apparent pathologic changes. The hypophysis of normal consistence weighed 60.8 cg. Microscopically the pars anterior was not changed. The number of eosinophiles was relatively large. In the pars intermedia there were several dilated acini which were filled by colloidal masses. In the capsule and one part of the pars posterior near the pars intermedia there was a metastatic mass. That these were not the migratory cells of the pars anterior was evident from their character and also from the fact that the latter were compressed by the former. The pedicle was not affected.

Since there were remarkable changes only in the pituitary body, but not in the kidneys and brain, it seemed probable that in both my cases the hypophysial disturbance must have had some intimate relation to the polyuria. The fact of the pars anterior showing no pathologic change coincides with the opinions of many writers that it is probably concerned with the growth of the body but not with the production of urine. Experimental resection of the pars anterior confirms this opinion.

Concerning the next problem, namely, the function of the pars posterior, we have as yet no accurate knowledge. That the resection of the pars posterior usually causes polyuria has been confirmed experimentally. Cushing says, under certain operative conditions which entail manipulations of the posterior lobe, a diuretic response and occasionally an extreme polyuria often occurs. Schaefer<sup>9</sup> observed that the subcutaneous implantation of the posterior lobe from one animal to another caused a temporary polyuria, which subsided in a few days, probably due to the absorption of the secondary product contained in the implanted tissue. Moreover, Schaefer and Herring<sup>10</sup> found that pituitrin, the extract of the posterior lobe, effected the contraction of almost all blood-vessels, notwithstanding the dilatation of the renal vessels. They concluded, therefore, that the diuresis in these cases was caused neither by the elevation of general blood-pressure nor the hyperæmia of the kidneys, but only by the direct irritation of the epithelial elements of the kidneys. As the posterior

lobe consists chiefly of connective tissue and glia cells it is not likely to have intensive secretory function. Crowe, Cushing, and Homans<sup>11</sup> believe the cyst colloid of pars intermedia should be made active by the passage through the pars nervosa. Biedl says the effects of pituitrin must be brought back to the mixed extract of pars intermedia. Schaefer believes the effective secretion is produced in the pars intermedia and goes directly into the infundibulum, thence to the brain ventricle. Herring found in the loose tissue of the pedicle the hyaline body, which is the secreting mass of the pars intermedia. The pars intermedia seems to play an important part in hypophysial secretions, especially in diuresis. Schaefer and Herring believe there are two substances contained in hypophysial secretion, the one secretion transmitting, the other secretion checking, the former being usually in excess. This intermediate part of the hypophysis is modified from the embryonal hypophysial lobe and forms in the human adult many big or small cysts with the colloidal mass, which are covered with cuboidal or columnar epithelial cells (Stendell).<sup>12</sup> The appearance is very like the follicles of the thyroid. That this part is of much significance in secretion is easily guessed from its morphology. Both of my cases seem to demonstrate that the stimulation of this part can excite the diuretic function of kidneys. Therefore Schaefer's theory is sustained in these instances. But it seems very difficult to explain Simmonds's second case, which showed the complete destruction of pars posterior, intermedia and pedicle by the tumor. Considering polyuria as a result of deficient secretion of these parts, he mentioned the investigations of Farmi,<sup>13</sup> Von der Velden,<sup>14</sup> and Römer,<sup>15</sup> in which the extract of the pars posterior and intermedia given by mouth or intravenously caused the reduction rather than the increase of urinal secretion. This latter explanation is of interest, provided he paid special attention to the pedicle. Of course, he described the pedicle as destroyed but it is important to ascertain if any of the pedicle was really there, because the hypophysial pedicle of the human being usually contains the same tissue as the pars intermedia and the latter may possess compensatory function.

On the other hand, Camus and Roussy<sup>16</sup> recently reported experiments on dogs and other animals, the results of which seem to show that the hypophysis is not responsible for diabetes insipidus. The seat of mechanism regulating the water content of the organism seems to be in the region just behind the hypophysis in the gray matter of the third ventricle. These writers think that the experiments on record and clinical experiences apparently demonstrating the connection be-

## HYPOPHYSIAL DISORDER IN MAMMARY CANCER

tween disorders of the pituitary body and diabetes insipidus have been misinterpreted; the inevitable concomitant injury of the region just to the rear of the hypophysis was probably the real cause of the diabetes. Notwithstanding, if we agree that the diabetes insipidus may have many factors in its etiology not wholly explained at present by hypophysial disturbances (Steiger),<sup>17</sup> we may still believe that the secretion of the hypophysis, especially that of the pars intermedia, has some causal relation to the polyuria. Many reports of experiments and clinical observations exclude the concomitant injury to the neighboring brain. My two cases give some evidence to the latter opinion.

### CONCLUSIONS

1. It is sometimes clinically noted that polyuria occurs in the last stage of cancer of the breast without any renal disorders.
2. In my two cases of cancer metastasis in the posterior lobe of the hypophysis were found no pathologic changes in the gray matter of the third ventricle.
3. My cases can be well understood by Schaefer's theory. The pars intermedia, compressed by tumor-mass in the pars posterior, developed a hypersecretory function and this secretion stimulated the epithelium of the kidneys to the overproduction of urine.

### REFERENCES

- <sup>1</sup> Forsbach and Weber: Beobachtungen über die Harn- und Salz-Ausscheidung im Diabetes insipidus. *Ztschr. f. klin. Med.*, 1911, lxxiii, 221-239.
- <sup>2</sup> Erdheim, J.: Zur normalen und pathologischen Histologie der Glandula thyroidea, parathyreoidea und Hypophysis. *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, xxxiii, 158-234.
- <sup>3</sup> Frank, E.: Über Beziehungen der Hypophyse zum Diabetis insipidus. *Berl. klin. Wchnschr.*, 1912, i, 393-397.
- <sup>4</sup> Cushing, H.: Concerning the Symptomatic Differentiation Between Disorders of Two Lobes of the Pituitary Body. *Amer. Jour. Med. Sc.*, 1913, cxlv, 313-328. Concerning Diabetes Insipidus and the Polyuria of Hypophysial Origin. *Boston Med. and Surg. Jour.*, 1913, clxviii, 901-910.
- <sup>5</sup> Cushing, H., and Goetsch, E.: Concerning the Secretion of the Infundibular Lobe of the Pituitary Body and Its Presence in the Cerebrospinal Fluid. *Amer. Jour. Physiol.*, 1910-1911, xxvii, 60-86.
- <sup>6</sup> Simmonds, M.: Hypophysis and Diabetes Insipidus. *Münch. med. Wchnschr.*, 1913, i, 127-128. Über sekundäre Geschwülste des Hirnanhangs und ihre Beziehungen zum Diabetes insipidus. *Münch. med. Wchnschr.*, 1914, i, 180-181.
- <sup>7</sup> Naegeli, O.: Über die neueren Forschungen auf dem Gebiete der Physiologie und Pathologie der Hypophysis. *Inaug.-Diss.*, Freiburg, 1911.
- <sup>8</sup> Tölken, R.: Zur Pathologie der Hypophysis, *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1912, xxiv, 633-644.

SHIGEKI SEKIGUCHI

- \* Schaefer, E. A.: Die Funktionen des Gehirnanhanges (Hypophysis cerebri). Bern, Drechsel, 1911, 39 p. Croonian Lecture, the Functions of the Pituitary Body. Proc. Roy. Soc. Lond., 1909, lxxxi, 442-468.
- <sup>10</sup> Schaefer, E. A., and Herring, P. T.: The Action of Pituitary Extracts upon the Kidney. Phila. Tr. Lond., 1908, s. B., cxcix, 1-29.
- <sup>11</sup> Crowe, S. J., Cushing, H., Homans, J.: Experimental Hypophysectomy. Bull. Johns Hopkins Hosp., 1910, xxi, 127-169.
- <sup>12</sup> Stendell, W.: Zur vergleichenden Anatomie und Histologie der Hypophysis der Hypophysis cerebri. Arch. f. mikr. Anat., 1913, lxxxii, 1. Abt., 289-332.
- <sup>13</sup> Farmi, F.: Über Diabetes insipidus und Hypophysistherapie. Gaz. degli osped., 1913, Abst. Wien. klin. Wchnschr., 1913, xxvi, 1867.
- <sup>14</sup> Von der Velden, R.: Die Nierenwirkung von Hypophysenextrakten beim Menschen. Berl. klin. Wchnschr., 1913, ii, 2083-2086.
- <sup>15</sup> Römer, C.: Die Beziehungen zwischen der Funktion der Hypophysis cerebri und dem Diabetes insipidus. Deutsche med. Wchnschr., 1914, xl, 108-111.
- <sup>16</sup> Camus, J., and Roussy, G.: Diabète insipidie et polyurie hypophysaire; régulation de la teneur en eau l'organisme. Presse Méd., 1914, xxii, 517-521.
- <sup>17</sup> Steiger, O.: Über einen Fall von Diabetes insipidus und seine Beziehungen zur inneren Sekretion resp. zum erweiterten Vagussystem. Deutsche med. Wchnschr., 1912, ii, 1869-1872.

## THE USE OF WARMED ETHER VAPOR FOR ANÆSTHESIA

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AND

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THE purpose of this investigation was to determine whether ether vapor warmed to body temperature possessed any advantages over ether vapor as ordinarily administered. Some observers<sup>1</sup> have claimed that warmed vapor is less irritating to mucous membranes than unheated ether, that it is more effective as an anæsthetic, smaller quantities being required to maintain anæsthesia, and that its use preserves for the patient the energy which would otherwise be expended in heating cold vapor to body temperature. Others, however, maintain that warming of anæsthetic vapors is unnecessary<sup>2</sup> and their claim seems to have the tacit consent of surgeons generally, as the specially warmed vapors have been used in but few of the large clinics. Ether administered by the open drop method and vaporized by the inspired air has proven to be so satisfactory and so nearly without danger, when properly administered, that most surgeons hesitate to give it up without assurance that the new method will offer definite advantages.

There are four standard methods of administering ether, *i.e.*, closed ether, open or drop ether, intrapharyngeal insufflation and intratracheal insufflation. It became our problem to determine, first, the temperature at which unwarmed vapor is delivered to the patient by the various methods, the degree of warming which occurs in the air-passages, and the amount of energy used in so warming the vapor; second, to observe the effects of warmed and cold vapor on animals as regards the quantity of ether required to induce and maintain anæsthesia, local irritation, and the effect on body temperature.\*

The apparatus used in determining the temperature of vaporized ether consisted of a tank so arranged that air from a foot bellows could be passed through the ether, over the surface of the ether, carried over the ether without coming into contact with it, or any combination of these routes; a mercury manometer attached to the outlet tube; a three-

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\* In these experiments dogs were used throughout.



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ounce glass bottle fitted with an inlet and outlet tube and carrying a thermometer for recording the temperature of the vapor as it passed through. A constant pressure of 20 mm. of mercury was maintained, corresponding to an alveolar pressure of 1 to 2 mm., the amount required in intratracheal anæsthesia, and air was passed through the tank at a rate of 10,000 c.c. per minute—the amount used in normal respiration. The results of such an experiment are shown in Table I.

TABLE I

	Start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
A. Temperature of vapor passed through ether (°C.) .....	21°	16.5°	13°	10°	8.5°	8.5°	8.5°
B. Temperature of vapor passed over ether (°C.) .....	22°	17°	14°	12.5°	12.2°	12°	12°

Other observers<sup>3</sup> have recorded considerably less fall in temperature in similar experiments, the variation in results being due, probably, to the fact that they recorded the temperature of ether vapor discharged into a large capacity rubber bag. Such a bag is not generally used in administering ether vapor.

The vapor temperature in this series reached a minimum of 8.5° C. in most of the experiments, the time required to reach this varying with the percentage of ether vapor in the mixture. In some cases the temperature failed to go below 12° C. and it was found that such was the case on days in which atmospheric humidity was high (Table II).

TABLE II

	Humidity	Temperature of ether vapor—°C. at						
		Start	6 min.	10 min.	15 min.	20 min.	25 min.	30 min.
	per cent.							
	62	17°	16°	12°	10.5°	9°	8.6°	8.5°
	81	21°	15°	12.5°	14.5°	11°	11°	11°
Air bubbled through water before being used to vaporize ether. ....	100	18°	17°	15°	14°	13.8°	12.5°	13.5°

With the idea of determining the most efficient method of producing warmed ether vapor, three ways were tried. The ether was first vaporized by passing through it a current of heated air. This was impractical because very hot air was required and, owing to the low boiling point of ether, there was danger of distilling ether into the receiving jar. When ether was warmed directly by immersing the tank in hot water

## WARMED ETHER VAPOR FOR ANÆSTHESIA

the same held true. The method of heating the vaporized ether by passing it through a coil of tubing immersed in boiling water was found to be reliable and satisfactory.

In observing the effects of unwarmed vapor, the cone, intrapharyngeal, and intratracheal methods were used. With dogs it was not practical to follow the technic of the drop method as used in the Presbyterian Hospital and, in its place, the following scheme was adopted. A tin can, open at one end and with numerous perforations through the other, was taken. A few layers of gauze were placed in the bottom of the can, covering the perforations, and ether was dropped on the gauze through the openings. The open end of this improvised inhaler was fitted closely over the muzzle of the dog so that almost all of the air breathed passed through the gauze. The bulb of a thermometer was placed in the inhaler and a second one was inserted into the trachea through a tracheotomy incision. Care was taken to prevent the intratracheal bulb from coming into contact with the mucosa.

In the intrapharyngeal and intratracheal methods, the vapor was passed first through a glass jar containing a thermometer bulb to record the temperature at delivery to the patient, and from this it was passed into a catheter which was inserted, in the first instance, through the nares into the pharynx, and in the latter, through the mouth directly into the trachea. By placing a thermometer in the trachea or in the pharynx through a high tracheotomy incision, as the case might require, we were enabled to determine the temperature of the vapor at the point of delivery in pharynx or trachea, and, furthermore, since the temperature of the vapor before entering the mouth was known, it became possible to estimate the efficiency of the various parts of the respiratory tract as heating chambers.

As a check on this method the intubing catheter was carried out through a tracheotomy incision directly into a bottle which was provided with a thermometer and inlet and outlet tubes. As a further check lengths of tubing equivalent to those used intrapharyngeally or intratracheally were enclosed in an incubator at 37.5° C. and the change in temperature of the vapor recorded as it passed through this tubing at the same rate as it had been passed into the trachea. The degree of warming of the vapor corresponded closely in this artificial respiratory tract to that observed in the dog.

Before concluding the intratracheal experiments the main bronchus to the lower lobe of one lung was opened, a thermometer inserted and the temperature of the vapor at that level recorded. In the following

table the results of such an experiment are recorded (Table III). The temperature of the air-ether vapor mixture before delivery corresponded to that noted in Table I, *B*.

TABLE III

	Start	5 min.	10 min.	15 min.	20 min.
Inhalation cone—temperature in trachea (°C.) . . . . .	37.5°	37.5°	36.6°	36.5°	35.5°
Intrapharyngeal—temperature in mouth (°C.) . . . . .	17°	17°	17°	17°	17°
Intrapharyngeal—temperature in trachea (°C.) . . . . .	35°	35°	34.5°	34.5°	34.5°
Intratracheal—temperature in trachea (°C.) . . . . .	23.5°	23.5°	23.5°	24°	23.5°
Intratracheal—temperature in bronchus (°C.) . . . . .	33°	33°	33°	33°	

These findings seem to indicate that when ether is administered by inhalation, unwarmed, the vapor reaches the middle of the trachea at a temperature within one or two degrees of body temperature. In intrapharyngeal insufflation, where the warming effect of the mouth is partially lost, the temperature in the trachea is 3 or 4 degrees below body temperature. It is safe to assume, however, that in both instances the temperature is increased to that of the body before the vapor has passed through the primary bronchi. When the unheated vapor is delivered through a catheter inserted nearly to the tracheal bifurcation it is delivered considerably below body temperature, about 14° C., but of this deficiency 10° has been added by the time the primary bronchus has been passed so that the vapor unquestionably has been warmed to body temperature long before it reaches the alveoli.

Having determined the temperature at which the anæsthetic was delivered by the various methods and having determined that regardless of the temperature at which it enters the mouth the vapor is raised to body temperature before reaching the alveoli, two questions arose: Has the cold vapor any local injurious effect on the mucosa, and, is the amount of energy required to warm the vapor a serious tax upon the organism as a whole? The answer to the first question we attempted to find by comparing the local effects of warmed and unwarmed vapor and by observing the evidences of local irritation following anæsthesia. It was noted by direct observation of the trachea during the administration of cold vapor, and at autopsy, that there was a slight general injection with a moderate amount of mucus but no specially marked change opposite the outlet of the catheter. No difference was noted in the findings after warmed or unwarmed vapor and no difference could be noticed during convalescence. This agrees with the report of Meltzer,<sup>4</sup> who regards the preliminary heating of ether vapor unnecessary for intratracheal anæsthesia.

# WARMED ETHER VAPOR FOR ANÆSTHESIA

The second question we attempted to answer by inquiring whether warmed vapor is more actively anæsthetic and therefore effective in smaller quantities, and whether the amount of energy expended in warming the vapor is consequential in proportion to the quantity lost in other ways or to the total amount of energy in the body.

A series of dogs was anæsthetized by the intratracheal method, each dog being used twice, once with warmed and once with unwarmed vapor (Table IV).

TABLE IV

	Times, Minutes	Total Ether, c.c.	Ether per minute, c.c.
Unwarmed vapor throughout.....	60	185	3.0
Warmed vapor throughout.....	70	225	3.2
{Started with unwarmed.....	30	125	4.6
{Continued with warmed.....	45	125	2.8
{Started with warmed.....	45	200	4.4
{Continued with unwarmed.....	45	120	2.6

No marked difference in the amount of ether required was observed and, after the first half or three-quarters of an hour, surgical anæsthesia by either method was maintained with approximately a 6 per cent. ether vapor—the concentration which was found necessary by Connell.<sup>5</sup>

In estimating the amount of energy required to warm cold ether vapor to 37.5° C. we assumed that the vapor was delivered at the lowest temperature, 8.5° C., which we were able to obtain and so had to be heated 29° C. The amount of heat in the body, assuming a weight of 150 pounds, is about 2100 cal., and the heat used up in 24 hours averages 2700 cal. at rest, or 3500 cal. at moderate work, a saving of 35 cal. per hour in the recumbent position. Of this heat loss a little less than 3 per cent. is used up in respiration, that is, in warming the air to body temperature and in the evaporation of water from the lungs. The loss of heat in breathing air at a temperature of 8.5° C. for one hour is 3.6 cal., the specific heat of air being 0.26, whereas the loss of heat in warming the same amount of air containing 6 per cent. ether vapor which has a specific heat of 1.025 is 3.95 cal., an increase of about one-third calorie per hour. The total energy required in heating air and ether vapor from 8.5° C. for one hour is about the equivalent of the energy expended in climbing 75 ft. of stairs. The amount of energy expended in breathing air in an operating room at 27° C. (80° F.) is 1.15 cal. per hour when no anæsthetic is used, so that the increased energy required to breathe ether-vapor-air mixture at its minimum temperature is about 2.83 cal. per hour.

The amount of heat lost in respiration is small when compared with the larger amount lost by radiation and conduction from the skin surface, the latter being 10 times as great under ordinary conditions, and much larger under the influence of anæsthesia when the peripheral blood-vessels are dilated and sweat-gland activity is increased. As a factor in saving energy it would seem that the use of a warm ether vapor was far less important than the prevention of excessive loss of heat by the skin. One can imagine poor operative risks in whom even the loss of 2.83 cal. might affect the outcome unfavorably. In such extreme cases it is questionable whether a general anæsthetic would be the anæsthetic of choice in any event.

Reichert<sup>6</sup> has demonstrated that when dogs are thoroughly morphinized the rate of energy production, as measured by a calorimeter, may decrease 80 per cent. This is due largely to the inhibition of muscular and glandular activity. Similarly, when animals are subjected to a general anæsthetic, as a result of the more or less complete muscular relaxation and possibly some disturbance of the heat regulating centre, heat production decreases, the rate of heat dissipation influenced by the cutaneous vasodilation and sweat-gland activity probably increases, and the temperature falls. Theoretically the decrease in the rate of heat production, the increase in the rate of heat dissipation, and the fall in temperature should be proportional, roughly, to the depth and duration of the anæsthesia. One advocate<sup>7</sup> of the practice of heating anæsthetic vapors, whose work has been quoted as proof positive of the correctness of the procedure, reported as follows: In a series of patients anæsthetized with unheated ether the fall in body temperature averaged .57° C.; in a second series of patients anæsthetized with heated ether the average fall in temperature was .18° C. The refrigerating effect of the unheated ether was assumed to be responsible for an average decrease in temperature of .39° C. For a patient weighing 70 kilos this fall in temperature would be indicative, on the above hypothesis, of the loss of 27.3 calories—which is seven times as much as would actually be used in an hour's anæsthesia with the coldest air-ether vapor mixture obtainable with any apparatus now at hand for administering ether in anæsthesia. In a series of 20 dogs, 10 of which we anæsthetized for an hour with unheated ether and 10 with heated ether, the fall in temperature per pound was .004° C. greater for the dogs of the unheated ether group than for the others. If we had stopped with the eighteenth dog of the series our result would have been exactly the opposite. In other words, the factors which are difficult to control are so large and the difference between the influence of the unheated ether and the



## WARMED ETHER VAPOR FOR ANÆSTHESIA

warmed ether is relatively so slight that only a very long series of minutely controlled animal or clinical experiments would be of any value in its determination.

### CONCLUSIONS

1. The amount of heat required to warm ordinary ether vapor as used in anæsthesia by the open or closed methods, or by intrapharyngeal or intratracheal insufflation to body temperature, is so small as to be a negligible factor in lowering body temperature and inducing shock in anæsthetized patients.

2. The warming of ether vapor, however administered, is accomplished in the mouth, pharynx, trachea and primary bronchi, and the anæsthetic reaches the alveoli at body temperature.

3. The quantity of ether required to produce and maintain anæsthesia does not appear to be materially influenced by warming ether.

4. So-called cold ether vapor does not appear to be more irritating to mucous membranes than warmed ether.

5. No more mucus and saliva is secreted when anæsthesia is induced and maintained with cold than with warmed ether.

### BIBLIOGRAPHY

- <sup>1</sup> Coburn: Med. Rec., N. Y., 1913, lxxxiii, p. 382.
- <sup>2</sup> Seelig: Interstate Med. J., 1911, xviii, p. 927.
- <sup>3</sup> Cotton and Boothby: ANN. OF SURG., 1913, lvii, p. 43.
- <sup>4</sup> Meltzer: Med. Rec., N. Y., 1910, lxxvii, p. 477.
- <sup>5</sup> Connell: Surg., Gyn. and Obs., 1913, xvii, p. 246.
- <sup>6</sup> Reichert: Philadelphia Med. J., 1901, vii, p. 474.
- <sup>7</sup> Davis: Johns Hopkins Hosp. Bul., 1909, xx, p. 118.

## TOLUOL

ITS ADVANTAGES OVER CHLOROFORM OR ALCOHOL AS A STORING FLUID FOR SURGICAL CATGUT

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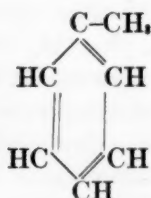
TOLUOL,  $C_6H_5CH_3$

Synonyms:

Toluene.

Methylbenzene.

Phenylmethane.



It is now generally conceded that the most dependable method of sterilizing catgut sutures is that originally proposed by Krönig, whereby the suture material, submerged in cumol, is subjected to a high degree of heat ( $165^{\circ}C.$ — $329^{\circ}F.$ ).

Considerable difficulty, however, has heretofore been experienced in obtaining an entirely satisfactory medium for storing the sterilized suture materials in the tubes after their sterilization.

Cumol itself, while possessing superlative virtues as a medium for thermal sterilization, was found to be inadequate as a storing fluid, owing solely to its slow evaporation. On the other hand, its favorable qualities, namely, its high boiling point, stability, and absence of hygroscopic properties, were highly desirable.

In eliminating as many as possible of the sources of untoward surgical results, it has been found necessary to employ a storing fluid superior to chloroform for the following reasons:

First, chloroform breaks down under comparatively moderate heat into chlorine and hydrochloric acid, both of which exert an extremely harmful effect upon the gut.

Second, under the influence of sunlight, free chlorine, hydrochloric acid, and carbonyl chloride (phosgene) are liberated, the latter product in particular being extremely objectionable.

Third, the susceptibility of chloroform to deterioration from age.

Fourth, the inadequately low boiling point of chloroform.

Fifth, the very undesirable indurating or stiffening action which chloroform exerts on the collagen structure of the gut.

## TOLUOL FOR SURGICAL CATGUT

Sixth, the disagreeably irritating effect of chloroform upon the tissues.

The chief difficulty in using alcohol as a storing fluid is the difficulty of freeing it from water and of maintaining its anhydrous condition.

Cumol, being a trimethyl substitution product of benzene, suggested the use of one of the simpler and more volatile methylbenzene compounds. Tests conducted with all of these demonstrated that the mono-methyl substitution product of benzene, known as toluol, possessed the desired qualities.

Toluol is a light, colorless, bland, aromatic hydrocarbon of definite constitution, of the benzene series, boiling at  $111^{\circ}\text{C}$ . ( $231.8^{\circ}\text{F}$ .), freezing at  $-93^{\circ}\text{C}$ . ( $-135.4^{\circ}\text{F}$ .), specific gravity 0.8723 at  $15^{\circ}\text{C}$ . Toluol is a very stable compound, not being decomposed by either heat, light, or age, as is chloroform. It was formerly derived from the dry distillation of the tolu balsam, but is now obtained on a much larger scale and in a state of greater purity from the distillation of coal-tar. It is very volatile, and has a pleasing and refreshing aromatic odor.

Unlike chloroform, toluol will not hold water in solution. This is a great advantage in the sterilization of catgut, as it is well known that the slightest degree of moisture tends to convert the collagen in the gut into gelatin, with the result that when the gut is subjected to thermal sterilization it becomes brittle, weakened, and twisted. Because of the composition of toluol there is no residue left upon evaporation, so that the sutures prepared with it will not be contaminated by foreign bodies. Toluol is a powerful solvent for oils and fats, and is therefore of great value in removing the irritant fats and fatty acids inherent to raw catgut. It clarifies the gut, imparting a transparency similar to that given by xylol in the preparation of histological sections.

Its softening influence upon the gut is quite marked when compared with the insufficiency of other oils and substances with which tests have heretofore been conducted.

Sutures stored in toluol when embedded in muscle, fascia, and peritoneum of animal and human subjects have been received kindly by the tissues, and have affected not in the slightest the period of convalescence.

Toluol itself when freely applied to superficial and deep wounds causes no irritating effects, either subjectively or objectively.

Toluol possesses a certain amount of germicidal ability, as found by T. H. C. Benians, M.R.C.S. (England), L.R.C.D. (London), Junior Assistant Inoculation Department, London Hospital. *Zeitschrift für*

ALLEN ROGERS

*Chemotherapie und verwandte Gebiete*, Leipzig, 1913, Verlag von Georg Thieme. His conclusions stated as follows:

1. Toluol has no effect on spores and very little on the staphylococcal group of organisms.
2. It readily destroys all organisms of the Gram-negative class.
3. It has a marked action on the tubercle bacillus and on the diphtheria and many diphtheroid bacilli.
4. It has a moderately well marked destructive action on the streptococcal organisms.
5. Disintegration and lysis of bacteria in emulsions exposed to the action of toluol does not readily take place whether they have been killed by the toluol or have resisted its action.

## ACUTE SECONDARY TUBERCULOUS SPLENOMEGALY: SPLENECTOMY

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R. C., eight years old, school boy, born in Italy, was referred to the Long Island College Hospital by Dr. Thomas.

*Family History.*—Father has arrested tuberculous lung disease and negative Wassermann. Mother has arrested tuberculous lung disease and + + + Wassermann. One brother and three sisters are well.

*Past History.*—December 16, 1913, operation for cervical adenitis left side of neck. Three months ago abscesses opened above left clavicle.

*History of Present Condition.*—One week after abscesses he had a slight chill, next day developed soreness on left side of abdomen. He had fever at night, his appetite was poor and he lost flesh. A tumor appeared below the ribs on the left side and grew rapidly.

*Chief Complaint.*—Pain and swelling just below the ribs on the left side.

*Physical Examination.*—Dusky pallor of the skin. Thin, anæmic, tongue coated, pulse accelerated, and temperature 102°. Head: Features coarse, lips thick, eyes normal, teeth separated and in fair condition, ears, mastoid, and thyroid negative, pharynx normal, tonsils enlarged, no palsies. Glands: Scar of operation on glands left side of neck, a few small glands on both sides of the neck. Chest: Non-active foci of tuberculosis in both lungs. Heart: Normal. Abdomen: Asymmetric, left upper quadrant was distended by an enlarged spleen. Peritoneum and other abdominal organs negative. X-ray (Fig. 1) shows large bronchial glands and diseased lungs. Kidneys normal. Blood examination: 3000 white blood-cells, 2,960,000 red blood-cells, 82 per cent. polymorphonuclears, 6 per cent. small lymphocytes, 4 per cent. lymphocytes, 8 per cent. transitionals, 65 per cent. hæmoglobin. Wassermann negative. Marked acidosis.

*Literature.*—Warren J. Collins, The Surgery of Spleen, ANN. SURG., 1910, xxxiii, 513-543, tuberculosis as an indication for splenectomy. H. Z. Griffin, Clinical Notes on Splenectomy, ANN. SURG., 1915, lxii, 166-172, one case of tuberculosis in list of splenectomies.



*Decision to Operate.*—Raised the question of general miliary tuberculosis, character of the organ involved, impossibility of surgically eradicating the disease, severe anæmia, and acidosis. Answered as follows: Disease arrested in lymphatic glands and lungs; miliary invasion in spleen only, therefore splenectomy would eradicate in same way as excision of glands. Spleen had lost its value as a blood-making organ. Acidosis could be controlled by intravenous injection of sodium hydroxide.

*Preparation for Operation.*—Hypodermic of morphine and atropine, 25 c.c. N/20 NaOH intravenous.

*Operation* (July 21, 1915).—Splenectomy under general and local anæsthesia.

*Findings.*—Enlarged diseased spleen. No adhesions. Other abdominal contents normal.

*Procedure.*—Spleen delivered through left Bevan incision, pedicle transfixed, vessels tied, and wound closed without drainage.

*Specimen* (Figs. 2 and 3).—Spleen weighed 950 grammes, it measured 19 cm. long, 9.5 cm. broad, 4.5 cm. thick, surface irregular and microscopical examination showed it filled with very young tubercles (see illustrations).

*Clinical Course.*—No shock. Temperature 104° that night; dropped to 99.1° next morning and remained near 100 for over two weeks. The wound healed *per primum*. July 24, blood examination, 5150 white blood-cells, 3,160,000 red blood-cells, 70 per cent. hæmoglobin. August 10, his temperature went up, he lost his appetite, the glands of his neck swelled, and he began to lose weight. He showed signs of active lung disease, he was sent to the roof to sleep out doors. He did not improve, so it was decided to transfuse him.

*Decision to Transfuse.*—September 13, the father's blood showed 4600 white blood-cells, 4,900,000 red blood-cells; hæmolysis, agglutinin, and precipitin tests with child's blood were negative. He was given 25 c.c. N/10 NaOH on September 13 and 14 to increase his leucocytes and counteract acidosis. September 15, father's blood, 8400 white blood-cells; September 15, child's blood, 8320 white blood-cells, 4,000,000 red blood-cells, 65 per cent. hæmoglobin. He was given 25 c.c. N/20 NaOH intravenously to neutralize acidosis. The father had arrested tuberculosis (see Fig. 4), so the question of tuberculous bacteræmia came up for consideration. It was decided that the father had educated leucocytes and specific antitoxin in his blood, since he was protecting himself. There was small chance of bacteræmia pointed out in the literature: *Schmidt Jahrbuch*, March, 1913, cccxvii, Hft. 2, 201. Tubercle Bacilli in the Blood, *Jour. Inf. Dis.*, 1914, xiv, 162.

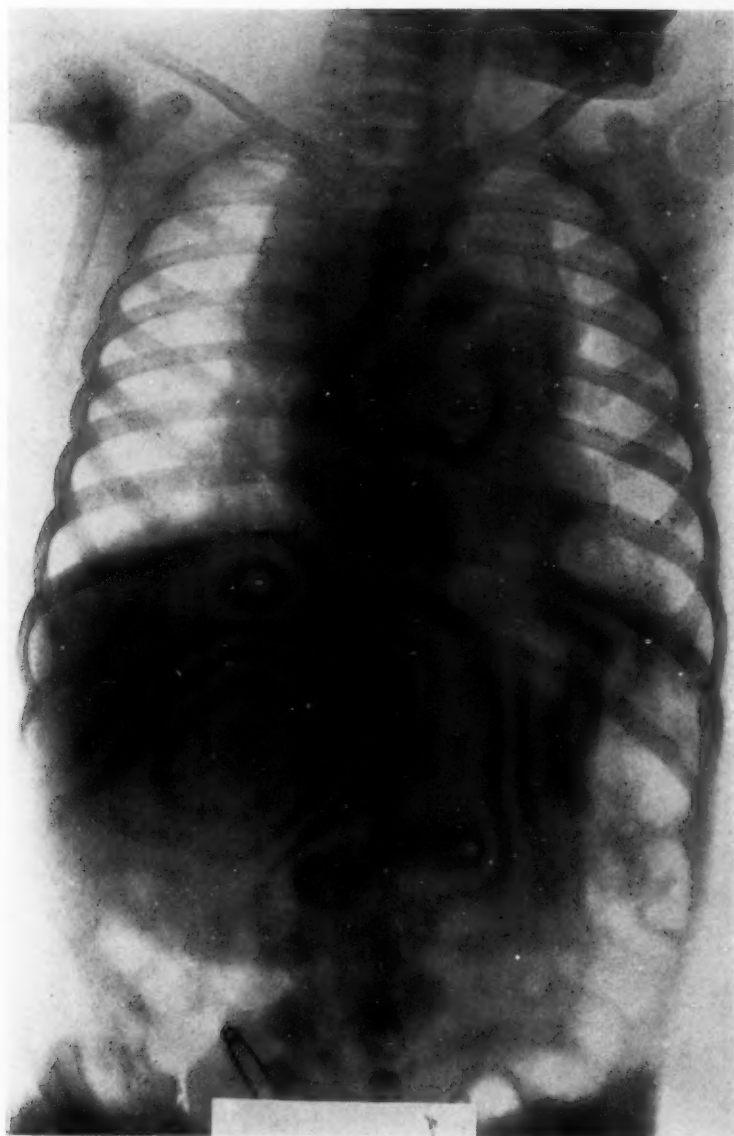


FIG. 1.—Röntgenogram of child's chest. Shows diseased lungs and large bronchial glands.



FIG. 2.—Photograph of gross section of diseased spleen removed. Shows convex surface and cut surface.

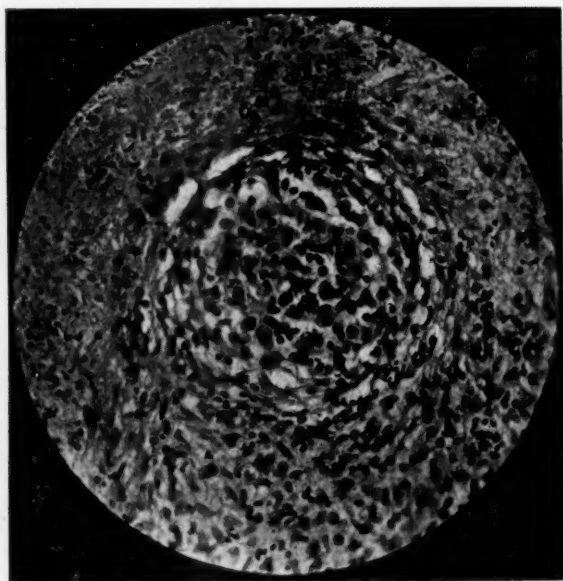


FIG. 3.—Microphotograph of tubercle from spleen.

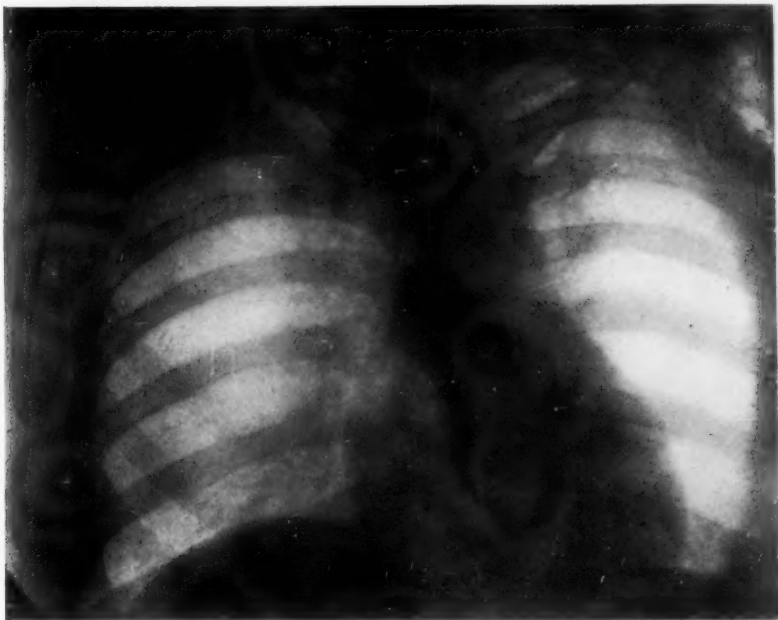


FIG. 4.—Röntgenogram of father's chest before transfusion. Shows arrested tuberculous disease of the lungs.



FIG. 5.—Photograph of child's abdomen after operation.

Form P (Rev. 11-15-57)

# THE LONG ISLAND COLLEGE HOSPITAL

NAME: 1980 K1 22 23 24 25 26 27 28 29 30 31   
 SERVICE OF DR.: August   
 HOSPITAL NO.: 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

DATE: July   
 TIME: 12:00   
 ROOM: 202   
 NURSE: 1   
 PHYSICIAN: 1   
 OPERATOR: 1   
 DEFICATOR: 1   
 LABEL: 1   
 OZ: 1   
 HOUR: 1

BEGIN ON THIS SIDE OF SHEET  
 BEGIN ON OTHER SIDE OF SHEET

The ECG tracing shows a regular rhythm. The first annotation 'Operation' is written above the tracing at approximately 100 mm on the horizontal axis. The second annotation 'Transfusion' is written above the tracing at approximately 250 mm on the horizontal axis. The tracing continues across the grid with a consistent heart rate and rhythm.



## ACUTE SECONDARY TUBERCULOUS SPLENOMEGALY

*Operation.*—Lindermann transfusion, 200 c.c. hydroxylized blood from father.

*Result.*—Child's temperature dropped to normal within eight hours and remained lower. His weight increased and the swollen glands disappeared by October.

*Theory.*—Sodium hydroxide throws down protective substances from protecting cells and increases the number of leucocytes, therefore hydroxylized blood from an arrested tuberculous case would be a valuable specific antiprodukt. It is an antacid, so neutralizes acidosis.

His temperature gradually rose and the glands in his neck began to swell the second week in October. He became worse, lost his appetite, and on October 29, developed a cultural diphtheria with a purulent discharge from his right nostril. He was transferred to the Contagious Disease Hospital. He developed dacryocystitis, became dull and stupid, showing profound toxæmia, and he died on November 14, 1915, with his lungs and glandular system thoroughly invaded with miliary tubercles.

*Conclusions.*—The tuberculous disease was not confined to the spleen and glands at the time the spleen was removed, so that procedure was futile in arresting the disease. The operation, however, was justified as it promised the only chance in the presence of such an overwhelming invasion. The transfusion should have been done immediately both before and after the operation to get the best benefit from immunity.

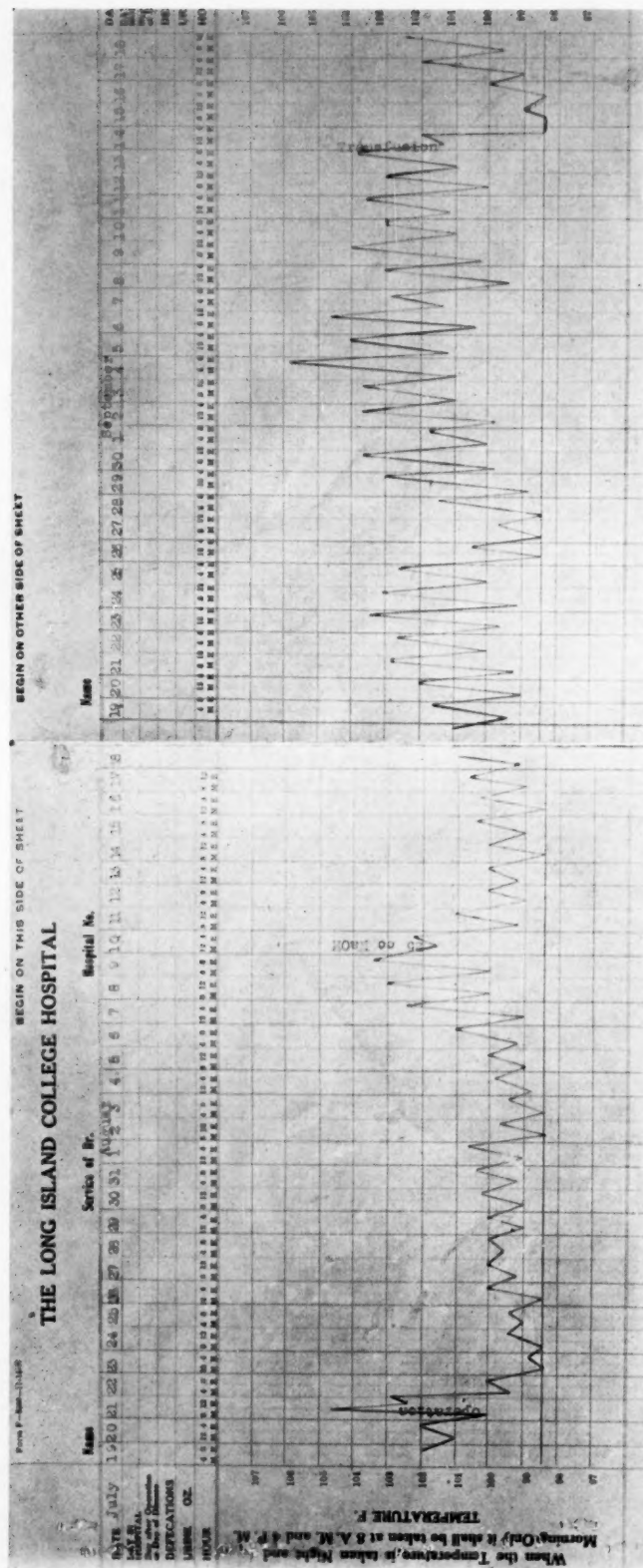


FIG. 6.—Temperature chart.

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# THE ANATOMICAL AND PHYSIOLOGICAL SUBDIVISIONS OF THE DUODENUM, WITH A NOTE UPON THE PATHO- GENESIS OF ULCER

A PLEA FOR THE RATIONAL CLASSIFICATION OF DUODENAL LESIONS

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AND

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*The Anatomical and Physiological Subdivisions of the Duodenum, and the Classification of Duodenal Lesions.*—It is not until we come to consider problems of normal and of abnormal physiology that anatomical boundaries are put to the test and flaws sometimes discovered. The subdivisions of the duodenum as commonly given in anatomical text-books are very artificial and are neither physiological nor embryological. The use of these subdivisions as the basis of classification of duodenal lesions leads to misunderstanding and inaccuracy, and at the same time obscures the proper interpretation of the diseases to which this part of the alimentary tract is subject.

*The Subdivisions of the Duodenum According to Academic Anatomy.*—The duodenum forms the first twenty-seven centimetres or so of the small intestine, from which last it differs more because of its fixation to the posterior abdominal wall, than because of any extreme peculiarity of structure. Its fixation is not so great but that it can glide upward and downward as a whole during the movements of respiration.<sup>1</sup> The only portion to be completely peritonealized is the first inch. The duodenum does not lie in the same plane in its whole length, the descending portion being in the sagittal plane, almost at right angles to the rest of its course. The usual anatomical description of the duodenum divides it into three<sup>2</sup> or four parts, or alternately into superior, descending, horizontal, and ascending limbs.<sup>3</sup> The first part ends at the neck of the gall-bladder,<sup>a</sup> the second or

<sup>a</sup> The downward bend which the duodenum takes at this point, the superior duodenal flexure or angle, is sometimes used as an additional divisional mark. There are two disadvantages in this for the surgical pathologist: (1) The angle involves over an inch of gut and hence is not a very exact delimiting point. (2) Cicatricial contraction of the bowel wall may flatten out the angle altogether.

## SUBDIVISIONS OF THE DUODENUM

descending portion terminates at the inferior duodenal angle (opposite the fourth lumbar vertebra), where the gut bends upward and to the left to enter on its third portion, which extends to the duodenojejunal flexure. The bile-papilla (papilla major Santorini) is situated a little proximal to the centre of the descending or second part. It is a remarkable fact that the papilla has not been used as a divisional mark, save by one or two clinicians, since such a division would be not only convenient but embryologically correct. For from the developmental side the duodenum is divisible into two parts, the dividing line being at the papilla major Santorini. The cephalad part arises from the foregut in common with the stomach and part of the oesophagus, whilst the caudad part, with the small intestine proper, is a derivative of the midgut. From this point of view it may be argued that the duodenum stretches from the pylorus to the bile-papilla and that the remainder is plain small intestine. This was suggested by Glisson<sup>4</sup> but the proposal found no favor with academic anatomy, which extended the limits of the duodenum, first to the point of crossing of the superior mesenteric vessels, later to the flexura duodenojejunalis. To this day there is dispute as to what point constitutes the proper termination of this loop of gut, for Villemin<sup>5</sup> in 1911 and again in 1913 drew attention to the fact that the true duodenal structure is lost at a point 1 to 3 centimetres proximal to the duodenojejunal flexure. This question has a certain academic interest, for if Villemin is right neoplasms of the flexura, two examples of which are mentioned by Mayo,<sup>6</sup> belong to the jejunum, and not to the duodenum.

It is important to remember that the duodenum is given a separate name in contradistinction to the rest of the small intestine not because of any extreme peculiarity of origin or structure,<sup>b</sup> but mainly because it forms a loop which is fixed to the posterior abdominal wall and largely unperitonealized in contrast to the mobile lengths which follow. It is obvious that until the fetal intestine has rotated and become fixed no duodenum (as we see it in the adult) exists, though it is usual to regard as such the small portion of intestine proximal to the papilla.<sup>c</sup>

The object of these remarks is to show that the duodenum as a cephalad and caudad to the bile-papilla (papilla major Santorini), is

<sup>b</sup> It is true that the duodenal wall contains Brunner's glands whose acini penetrate the muscularis mucosæ. They are very numerous above the papilla, but become more sparse below this point and disappear altogether proximal to the flexura duodenojejunalis.

<sup>c</sup> See, however, a new account of the development and fixation of the duodenum—Frazer and Robbins, *On the Factors Concerned in Causing Rotation of the Intestines in Man*. Jour. Anat. and Phys., October, 1915.



whole is a more or less artificial subdivision of the intestinal tract, and that anatomy has paid more attention to peritonealization than to embryology. There is much justice and convenience in keeping intact under one name this fixed loop of gut, but it is unfortunate that the bile-papilla has not been used as a divisional mark, as it is the only logical boundary which this portion of the alimentary canal contains. The present limit between the first and second portions is singularly unfortunate, for it does not depend on any flexure or alteration in the wall of the bowel but upon the contiguity of the latter to the neck of the gall-bladder—an extrinsic, deep, and far from immobile mark. This is disadvantageous to pathology, for disease processes are very apt to distort normal relationships; Moynihan remarks the difficulty of deciding whether an ulcer lies in the first or in the second part.<sup>7</sup> It is very doubtful whether the statistics of duodenal ulcer are at all trustworthy on this point, as a search of the literature has taught us.

*Discontent with Existing Subdivisions.*—Dissatisfaction with the ordinary descriptions and divisions of the duodenum has been expressed from time to time (see Jonnesco, Charpy and Dieulafé, p. 284, *loc. cit.*) and has been revived lately by both surgeons<sup>8, 9</sup> and radiographers.<sup>1, 10</sup> These have focussed their attention on the proximal or juxtapyloric portion and have emphasized its special liability to ulcer and its characteristic X-ray appearances. Holzkecht has called it the "bulbus duodeni"; Cole, "the cap or pilleus ventriculi." Unfortunately these observers have not contented themselves with a declaration of the independence of this part of the small intestine, but have sought to include it in the stomach. None of the arguments for such a procedure so far advanced will bear close critical investigation. Much has been made of the common origin from the foregut of the stomach and proximal duodenum. If this is a valid reason for including the duodenum in the stomach, the inclusion of the lower part of the œsophagus might be demanded with equal logic. The œsophagus and stomach are physiological entities of determinate extent and this is equally, though not so obviously, true of the duodenum.

As already mentioned, the proximal duodenum is derived from the primitive foregut which ends at the bile-papilla. Here the liver and pancreas budded off. The duodenum below this arises from the midgut in common with the rest of the small intestine. It seems to us that the different embryological origin of the two parts of the duodenum, cephalad and caudad to the bile-papilla (papilla major Santorini), is best employed in emphasizing the individuality of the two moieties of this part of the digestive tube. The emphasis of individuality must

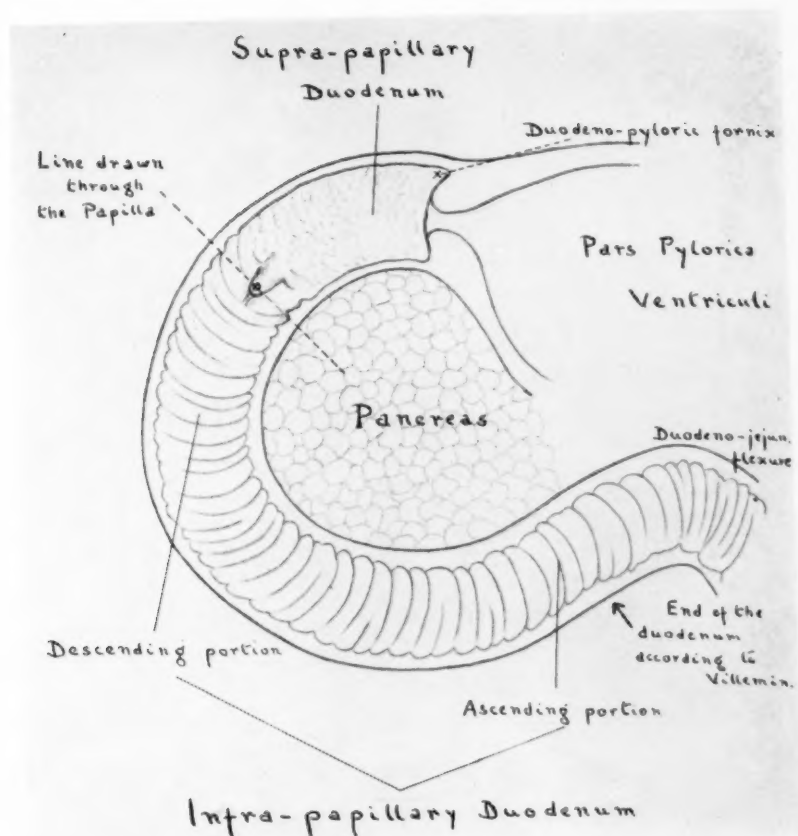


FIG. 1.—Schema of the proposed division of the duodenum by a line passing through the bile papilla. The proximal (cephalad) portion is the suprapapillary duodenum, the distal (caudad) the infrapapillary.



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not be too strong, for we are all the time accumulating evidence of the physiological unity of the whole gastro-intestinal tract (see for example the recent illuminating work of Alvarez<sup>11</sup> and of Keith).<sup>20</sup> Another serious drawback in the method of partitioning of the duodenum at present in vogue is that it is impossible to tell from ordinary pathological records what was the relationship to the papilla of any given lesion, unless this is separately and specifically stated. To say that a lesion is in the second part of the duodenum is to give no information at all as to whether it is above, below, at, or alongside the bile-papilla. Such information may be of considerable value (*vide infra*).

*Anatomical Division of the Duodenum with an Embryological and Physiological Basis.*—The only easily recognizable landmarks of this portion of the alimentary canal are: Its commencement at the duodenopyloric junction, its termination at the duodenojejunal flexure and the point of entrance of the bile and pancreatic ducts at the biliary papilla. At this latter point also the mucous membrane undergoes a change from a condition of fine "chagrination" to become arranged in crescents and spirals—the plicæ circulares (Kirkringi) or valvulae conniventes. The entrance of the bile and pancreatic ducts is not only the great event of the duodenum, but it is the only obvious orientating mark for subdivision. A division of the duodenum by a line drawn through the bile papilla meets the requirements of embryology and leaves nothing to be desired in the classification of lesions of this part.

We shall therefore divide the duodenum into two parts, cephalad and caudad to the bile papilla (major Santorini). The portion above this point will be called the "suprapapillary portion," that below the "infrapapillary portion" (see Fig. 1). These two parts are of unequal length, the latter being about twice as long as the former. The suprapapillary portion though short is of considerably more surgical importance than the lower part. Not only is it the favorite haunt of chronic ulcer, but it is rich in pancreatic rests<sup>12</sup> and is sometimes the site of diverticula.<sup>13</sup> The infrapapillary portion includes as much of the second or descending part of the duodenum as lies below (caudad to) the bile papilla, and the whole of the ascending part as far as duodenojejunal flexure. If, therefore, it is thought that it is not accurate enough to say simply that a lesion lies in the infrapapillary duodenum, one can qualify this by remarking

<sup>d</sup> Some authors would probably divide the infrapapillary duodenum into three parts: a descending, a horizontal, and an ascending part. The horizontal part is not always present. It is best seen in the U-shaped duodenum, less well in the C-shaped form (figured), and not at all in the V-form.

that it lies in the descending or in the ascending limb<sup>d</sup> of this division, so many centimetres from the papilla. There is nothing original in the suggested division of this fixed part of the alimentary canal. It has already been urged by Boas<sup>14</sup> and apparently also by Sherren,<sup>15</sup> chiefly for the classification of tumors. It is equally valuable for the grouping of ulcers, but it has not been accepted by English and American surgeons in general, owing, we feel sure, to an imperfect realization of the great superiority which this method has. It has one great advantage over the method of subdivision at present in vogue, and that is, that the dividing mark is an intrinsic anatomical feature in the wall of gut. This is a very important point, for nothing could be more difficult than to decide whether a given ulcer lies in the first or in the second part of the duodenum when the distinction depends on the relationship of the ulcer to the neck of the gall-bladder (which may be buried in adhesions).

A warning here as to nomenclature: The old term "first part of the duodenum" is not synonymous with the new one of "suprapapillary duodenum," for the latter includes the former and as much of the second part, besides, as lies above (cephalad to) the bile-papilla.

The duodenum has different physiological purposes in its different parts. The suprapapillary part is intimately concerned with the closing and opening of the pylorus, though other parts seem to be involved in this as well (Alvarez,<sup>11</sup> p. 390). There is also a difference of chemical reaction, for the first few centimetres of intestine are the only parts which have an acid reaction normally (Moore and Bergin).<sup>16</sup> It is very tempting to suppose that this explains the very high incidence of duodenal ulcer in the suprapapillary portion, whilst the alkalinity below the papilla accounts for the rarity of peptic ulcer there. To obtain evidence of this from existing statistics entails a rearrangement of these upon our new basis.

*The Incidence of Duodenal Ulcer in the Light of the New Classification.*—Moynihan, the Mayos, and Patterson agree that the vast majority of duodenal ulcers occur in the first three-quarters to one and a half inches of the duodenum, *i.e.*, well within the limits of the acid suprapapillary portion. They do not, however, give their own case figures as to the incidence of the lesion in the different parts of the duodenum, except that Moynihan says that 95 per cent. of his cases occur in the first part. One of us has been through Moynihan's

\* There seems to be some doubt on this point. But, possibly, if the rest of the intestine is sometimes acid it may be an organic acidity as opposed to an inorganic acidity near the pylorus.



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cases (Detailed Statement of Cases Operated Upon, p. 317, *loc. cit.*) The situation of the ulcer is definitely stated in 224 cases (counting actual ulcers and indurations, but not adhesions without definite ulcer). In no single case of all these was the ulcer below the papilla. It was near it in one or two only, and in one case (No. 180) jaundice was caused by adhesions to the common bile duct as it disappeared behind the upper margin of the duodenum. In all of 224 cases, the ulcer was suprapapillary. A similar examination of Perry and Shaw's cases<sup>17</sup> was made. Their statistics have been very widely quoted, by almost every one, in fact, who has written on duodenal ulcer. They state that of 149 ulcers, 123 were in the first part, 16 in the second, and only 2 in the third. These figures bring out, they say, two facts: That ulcers are practically confined to the portion above the biliary papilla, and that they are eight times more numerous in the first than in the second part. In going over their cases (which are all recorded in some detail) we have found that there were only two definitely infrapapillary ulcers; one was tuberculous (Case 66), the other uræmic (Case 151). Three ulcers were situated at the papilla itself (Cases 89, 141, 221). The remainder, 115 in number,<sup>f</sup> were all suprapapillary. Of more recent statistics, Peck<sup>18</sup> states that only 1 out of 71 ulcers was in the second part of the duodenum and this one was apparently suprapapillary. There are also 41 suprapapillary cases of Wilkie's<sup>20</sup> and 25 of Codman's.<sup>31</sup> This is not to say that ulcers are never found distal to the papilla, though they are certainly very uncommon there and authentic examples are few. Such an one is a case of Hartmann's recorded at length by Houdard.<sup>30</sup> A gastro-enterostomy was performed for pyloric ulcer; the patient died and at autopsy the ascending portion of the infrapapillary duodenum was found to be almost completely occluded by a second ulcer. The remaining 16 cases of Hartmann's series were all above the papilla.

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<sup>f</sup> Note by G. J.: Perry and Shaw (writing in 1893) used a peculiar classification—"duodenal ulcers associated with tuberculosis," "typhoid ulcers of the duodenum," "anthrax," "septic ulceration of the duodenum," "burns," "Bright's disease," and so on. It is evident that their valuable work includes duodenal ulcers of every conceivable etiology, but this fact precludes the use of their statistics as they stand in a discussion of the ordinary duodenal ulcer as we know it to-day. I have therefore gone over their cases and have been able to collect 118 examples of ordinary duodenal ulcer, not including in this figure tuberculous or uræmic ulcers, nor those due to poisons, nor to anthrax, nor to the bacillus typhosus. I have used these 118 cases as the partial basis of certain remarks above, believing them to be purer examples (as it were) than the 149 which Perry and Shaw have used for their statistics. Of the 118 cases, 115 were suprapapillary, and 3 papillary. None were infrapapillary.

Taking Moynihan's 224, Perry and Shaw's 118, Peck's 71, Wilkie's 41, Codman's 25, and Hartmann's 17 cases together, we have a total of 496 peptic duodenal ulcers in which the precise relationship of the lesion to the papilla is known. Of this number 492 were suprapapillary, 3 were papillary, and there was one infrapapillary ulcer.

We may therefore be justified in the following conclusions:

1. That the ordinary peptic ulcer of the duodenum has its site of election in the acid suprapapillary region.
2. That it decreases in frequency as the bile-papilla is approached.
3. That whilst it is rare at the papilla itself,
4. It is very uncommon in the infrapapillary portion of the duodenum.

*The Probable Pathogenesis of Duodenal Ulcer.*—The decreasing incidence of duodenal ulcer as the distance from the pylorus is increased is a very striking fact. The more so since the fundamental pathogenesis of this lesion seems to be a question of chemistry—of acidities and alkalinities. Something more than a mere acidity of some 0.2 per cent. is, of course, necessary to produce an ulcer here as elsewhere, but one of the first facts which was noted about these so-called "peptic ulcers" was their distribution in that part of the digestive tube to which the gastric juice has access in an unneutralized condition. Bolton<sup>10</sup> has made observations upon the rôle of the hydrochloric acid of the gastric juice in the causation of experimental ulcers. He has shown that if the gastric juice is kept neutralized artificially, ulcers do not occur. We know further that simple peptic ulcer in the jejunum is unknown until we let the acid gastric contents into it by a short-circuiting operation, though here again something more is usually needed before an ulcer will develop—in this case an indigestible piece of silk or linen thread (see an account of 125 collected cases, Marquis).<sup>20</sup>

An interesting case of peptic ulcer in the ileum has recently been published by Callender.<sup>21</sup> It lay in a Meckel's diverticulum, but this was lined with gastric glands of the fundic or acid-secreting type.

The reaction of the duodenum below the papilla during digestion must be strongly alkaline. Contrary to general belief, the duodenum exhibits very great activity, in its infrapapillary portion at least (Alvarez<sup>22</sup>), sweeping its contents on and not lying flaccid and inert as so many have supposed.

The experiments of Steinharter<sup>23</sup> and Rosenow<sup>24</sup> tend to show that bacteria play an important part in the production of ulcers. But something more still is needed before the experimentally produced

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acute ulcer will consent to become chronic. This third factor seems to be stasis. Bolton<sup>19</sup> believed that he could prevent his acute ulcers in animals from healing if he could cause delayed emptying of the stomach. Friedmann and Hamburger<sup>25</sup> have apparently succeeded in doing this, with the result that Bolton anticipated. Delay in the emptying of the stomach and delay in the passage of food through the duodenum can be produced by changes in the intestine at a distance (see Alvarez,<sup>11</sup> foot-notes, etc.). It seems to us very probable that a chronic appendicitis, the coexistence of which with gastric and duodenal ulcers has frequently been commented on, might not only supply the bacteria necessary, but might also cause the needed stasis by reflex action.

*The Classification of Duodenal Neoplasms, with Special Reference to Their Situation.*—For the classification of duodenal neoplasms the excellence of the nomenclature and method described above is more obvious. It has not been widely used, however, in spite of this. Rolleston,<sup>27</sup> for instance, has given the sites of duodenal carcinomata in 51 instances. The first part was affected alone in 8 cases, and together with the second part in 7 more; the second part was involved alone in 29 cases, and together with the first in 7, as just remarked; the third portion was the site of 4 growths, and together with the second in 1 more. In the light of modern knowledge of the close relationship which exists between carcinoma and preëxisting simple chronic ulceration, these statistics are rather surprising. For the second part, which is not commonly the site of ulcer, has by far the largest number of cancers. As they stand, however, the figures quoted do not tell the truth of duodenal cancer. When we speak of duodenal carcinoma we mean, or should mean, a carcinoma which has sprung from the mucous membrane which lines the duodenum. Now a very large number of cancers involving the second part of the duodenum have sprung from the ampulla Vateri or the two ducts which unite to form it, as Rolleston himself admits, and not from the duodenum proper at all.

If these tumors of the biliary tract are subtracted from the total of those occurring in the second part of the duodenum, very few remain.\* It is difficult to regroup Rolleston's collected cases on the "papillary" basis. A provisional grouping would be: Suprapapillary, 15+; infrapapillary, 5+; the plus sign representing the unknown num-

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\* Rolleston elsewhere<sup>28</sup> speaks of having notes of 19 cases of ampullary cancer. If these are all included in his 29 duodenal cancers of the second part, abstraction of these leaves 10 true duodenal tumors, i.e., less than the first part total, but more than the third.

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ber of true duodenal cancers of the second part (10 perhaps should be divided between the two groups; see foot-note).

Of 10 cases of duodenal cancer described by Perry and Shaw (*loc. cit.*) in their exhaustive paper, 6 were suprapapillary, 2 papillary and 2 infrapapillary, figures which bear out the regrouping above. These 10 cases of Perry and Shaw are probably included in Rolleston's 51 cases. Rolleston further states that three-quarters of the carcinomata of the small intestines originate in the duodenum. We do not think that this is so, if we limit ourselves to true duodenal tumors. It is doubtful whether carcinoma is commoner in the duodenum than elsewhere in the small intestine, save perhaps in the suprapapillary portion where the liability to chronic ulcer increases the possibility of malignant metaplasia. Cancer following duodenal ulcer is notably rare. We have so far been able to find only about 25 examples in literature.

### SUMMARY

1. The ordinary subdivisions of the duodenum as given in anatomical text-books are neither embryological nor physiological.

2. The duodenum is best divided into two parts cephalad and caudad to the bile-papilla. These parts are conveniently called "supra-" and "infrapapillary." This is not only developmentally correct, but stands the test of pathology.

3. An examination of certain statistics of duodenal ulcers shows that they are very common in the acid suprapapillary region; that their incidence decreases as the papilla is neared, and that they are extremely rare in the alkaline infrapapillary region. The normal physiological differences of these parts above and below the papilla is thus emphasized by pathology.

4. Statistics allege that duodenal carcinoma is commonest in the second part. This is fallacious and is due to the inclusion of Vaterian cancers in the total of duodenal neoplasms. When these have been subtracted carcinoma seems to be commoner in the suprapapillary region than in the infrapapillary part, possibly because of the greater incidence of chronic ulceration in the former.

### REFERENCES

- <sup>1</sup>Lippman, C. W.: The Duodenum: A Röntgen Study. Surgery, Gynecology and Obstetrics, xix, 1914, p. 724.
- <sup>2</sup>Waterston, D.: The Digestive System. Cunningham's Text-book of Anatomy, 4th Ed., London, 1913.
- <sup>3</sup>Jonnesco, Charpy and Dieulafoy: Duodénum. Traité d'anatomie humaine. Poirier and Charpy, vol. iv, fasc. 1, 1912.
- <sup>4</sup>Glisson: Quoted by Jonnesco, Charpy and Dieulafoy.

## SUBDIVISIONS OF THE DUODENUM

- <sup>5</sup> Villemin, F.: Lower Limit of the Duodenum. *Lancet*, Lond., 1913, vol. ii, p. 543.
- <sup>6</sup> Mayo, W. J.: Operative Results in Carcinoma of the Gastro-intestinal Tract. *Mayo Clinic Papers*, 1912.
- <sup>7</sup> Moynihan, Sir Berkeley: *Duodenal Ulcer*. 2nd Ed., London, 1912.
- <sup>8</sup> Mayo, W. J.: Ulcer of the Duodenum. *Journ. Amer. Med. Assoc.*, August, 1908.
- <sup>9</sup> LaRoque, Paul: Some Anatomic and Physiologic Principles Concerning Pyloric Ulcer. *ANNALS OF SURGERY*, lviii, 1913.
- <sup>10</sup> Cole, Lewis Gregory: Physiology of the Pylorus, Pilleus Ventriculi and Duodenum. *Journ. Amer. Med. Assoc.*, 1913, p. 762.
- <sup>11</sup> Alvarez, W. C.: The Motor Functions of the Intestine from a New Point of View. *Journ. Amer. Med. Assoc.*, lxxv, 1915, 338.
- <sup>12</sup> Opie, Eugene: *Diseases of the Pancreas*. 2nd Ed., Philadelphia, 1910.
- <sup>13</sup> Wilkie, D. P. D.: Duodenal Diverticula and Duplication of the Duodenal Wall. *Edinburgh Med. Journal*, 1913.
- <sup>14</sup> Boas: quoted by Nothnagel, Hermann: *Diseases of the Intestines and Peritoneum*. Amer. Ed., 1905.
- <sup>15</sup> Sherren, James, quoted by Bland-Sutton, Sir John: On Cancer of the Duodenum and Small Intestine. *Brit. Med. Jour.*, October 17, 1914.
- <sup>16</sup> Moore and Bergin, quoted by Cannon, W. B.: *The Mechanical Factors of Digestion*. London, 1911.
- <sup>17</sup> Perry, Cooper and Shaw, Lauriston: On Diseases of the Duodenum. *Guy's Hospital Reports*, 1893.
- <sup>18</sup> Peck, C. H.: Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, 1915.
- <sup>19</sup> Bolton, Charles: Recent Observations on the Pathology of Ulcer of the Stomach, with Indications for Treatment. *Brit. Med. Jour.*, i, 1915, p. 707.
- <sup>20</sup> Marquis: Perforation d'un ulcère peptique du jéjunum six ans après une gastro-entérostomie, etc. *Bull. et mém. soc. de chir.*, Paris, 1913, xxxix, 1517.
- <sup>21</sup> Callender, G. R.: Gastric Glands in Meckel's Diverticulum. *Amer. Jour. Med. Sci.*, cl, 1915, 69.
- <sup>22</sup> Alvarez, W. C.: Further Studies on Intestinal Rhythm. *Amer. Jour. Phys.*, xxxvii, 1915, 267.
- <sup>23</sup> Steinharter, E. C.: Experimental Production of Gastric Ulcers by Intravenous Injection of Clumped Colon Bacilli. *Lancet Clinic*, 1914, cxl, p. 87.
- <sup>24</sup> Rosenow, E. C.: Production of Ulcer of the Stomach by Injection of Streptococci. *Journ. Amer. Med. Assoc.*, November, 1913, p. 1947.
- <sup>25</sup> Friedmann, J. C., and Hamburger, W. W.: Experimental Chronic Gastric Ulcer; *Journ. Amer. Med. Assoc.*, 1914, lxiii, 380.
- <sup>26</sup> Keith, A.: A New Theory of the Causation of Enterostasis. *Lancet*, London, clxxxix, 1915, 371.
- <sup>27</sup> Rolleston, H. D.: *Diseases of the Small Intestine*. Allbutt and Rolleston's System of Medicine. 2nd Ed., London, 1908.
- <sup>28</sup> Rolleston, H. D.: *Diseases of the Liver, Gall-bladder and Bile-ducts*. Lond., 1912.
- <sup>29</sup> Wilkie, D. P. D.: Observations on the Pathology and Etiology of Duodenal Ulcer. *Edin. Med. Jour.*, September, 1914.
- <sup>30</sup> Houdard: L'ulcère simple du duodénum, non perforé. *Thèse de doct.*, Paris, January, 1913.
- <sup>31</sup> Codman, E. A.: On the Importance of Distinguishing Simple Round Ulcers of the Duodenum from Those Ulcers which Involve the Pylorus or Are Above It. *Boston Med. Surg. Jour.*, clxi, 1909, Postscript 1.



## ULCER OF THE DUODENOPYLORIC FORNIX

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DUODENAL ulcers, as is well known, have a peculiar partiality for the part of the duodenum immediately adjoining the stomach. Thus Moynihan<sup>1</sup> states that at least 95 per cent. of them lie within one and one-half inches of the pylorus, whilst Paterson<sup>2</sup> gives their common site as half that distance. The incidence of duodenal ulcer in the portion of the intestine proximal to the bile papilla is very striking, indeed infrapapillary ulcer will probably be found to be a great rarity. The inference to be drawn from this fact as to the probable rôle of the gastric juice in the production of these ulcers is, of course, obvious.\* The starting point of the majority of duodenal ulcers being so near the pyloric ring, it is not surprising that a certain number involve this structure and the fornix or sulcus which surrounds it. The complications which may then arise are discussed below.

*The Duodenopyloric Fornix.*—It will be remembered that the pylorus as viewed from the duodenum appears as a knob-like projection, which Cunningham<sup>4</sup> likened to the cervix uteri. He wrote, "The extremity of the pyloric canal protrudes into the commencement of the duodenum so that, when viewed from the duodenal side, it presents the appearance of a smooth, rounded knob with a small puckered aperture, the pyloric opening in its centre, and surrounded by a shallow groove or fornix.

"The resemblance which it presents, as I pointed out many years ago, to the portio vaginalis of the cervix uteri is very striking. . . . The circular fibres are disposed in the form of a thick sphincteric muscular cylinder which surrounds the entire length of the [pyloric] canal. At the duodenopyloric constriction the margin of this cylinder becomes increased in thickness, forming thereby the massive muscular ring which encircles the pyloric opening and constitutes the pyloric sphincteric ring. The knob-like appearance presented by the extremity of the pyloric canal when viewed from the interior of the duodenum is produced by the presence, beneath the mucosa, of this muscular ring."

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\* Bolton<sup>3</sup> has shown that it is the hydrochloric acid of the gastric juice which causes ulceration after local injections of his "gastrotoxin," for they fail to appear if the gastric juice is kept neutralized. If this work is substantiated the term "peptic" ulcer becomes a misnomer.

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The furrow which surrounds this knob is conveniently termed the duodenopyloric fornix. The depth of this sulcus varies very considerably in different individuals, being practically absent in many cases but very marked in others. The fornix is especially liable to be shallow in relaxed, hypotonic stomachs, whether seen at post-mortem or at operation, but is correspondingly deep in muscular, contracted specimens. The fornix, as we have seen, is due fundamentally to the muscle of the pyloric sphincter, but the eminence formed by the latter is accentuated by the mucous membrane which covers it. This last is frequently thicker on the duodenal aspect of the sphincter than it is immediately within the grasp of the same (Fig. 1 A). The writer has occasionally seen, in quite normal specimens, pockets of mucous membrane dipping beneath the general level of the floor of the fornix. This irregularity seems to be due in part to variations in the thickness of the submucosa and in part to the uneven line of the attachment to the pyloric ring of the longitudinal fibres of the duodenum. These small recesses must not be confused with the diverticula which sometimes develop in this region as the result of an ulcer (see Figs. 4 and 5 of Wilkie's paper<sup>11</sup>).

When it is remembered that gastric hypertonus is the rule in duodenal ulcer, as the radiographers have taught us, it will be evident that this sulcus is likely to be especially well marked in that condition. Truesdale<sup>6</sup> has recently furnished some anatomical evidence bearing on this point. From a study of the material removed at 15 pylorectomies he has shown that the musculature of the pyloric end of the stomach, including the sphincter, becomes considerably hypertrophied in ulcer cases, whilst it undergoes atrophy from partial disuse after gastroenterostomy.

*Clinical Importance of the Duodenopyloric Fornix.*—The suprapapillary duodenum<sup>\*\*</sup> is a comparatively simple, uncomplicated portion of the alimentary tract, somewhat egg-shaped<sup>6</sup> but smooth-walled, as the valvulae conniventes do not commence till we reach the mound made by the underlying ampulla Vateri.† The absence of valvules makes a rapid examination of the interior of this part of the duodenum easy, so

<sup>\*\*</sup> Or alternatively "the supra-ampullary" duodenum.

† L. G. Cole<sup>7</sup> from his radiographical observations regards this proximal duodenum as part of the stomach. This view has also been advanced by Mayo and by Laroque.<sup>8</sup> Cole calls it the "cap" to the stomach or *pilleus ventriculi*. His really beautiful skiagrams (*loc. cit.*) well repay careful perusal. They show the silhouette of the duodeno-pyloric fornix very clearly. In most of Cole's figures it is rather shallow, but the relationship which an ulcer invading this situation bears to the pylorus is clearly demonstrated (see Fig. 10 *loc. cit.*).

that it is almost impossible to overlook an ulcer however small. When an ulcer lies in the posterior fornix, however, it is quite possible for it to be hidden to a certain extent by the projecting pylorus, and this the more readily owing to the backward turn towards the sagittal plane which the proximal duodenum takes. Incidentally, it may be remarked that this twist has been thought by some to explain the frequency of duodenal ulcer on the anterior paries (44 anterior to 19 posterior—Peck<sup>9</sup>), since the acid chyme will be projected primarily against this wall. Wilkie denies this and believes that the arterial supply of the bowel wall explains the site of ulceration. The hiding of an ulcer in the posterior fornix has been alluded to by W. J. Mayo.<sup>13</sup> Difficulty in actual detection can only arise when the pylorus is markedly prominent and the ulcer small and recent.

There is a more important result of ulceration of the duodeno-pyloric fornix, however, and one which will be effective regardless of the depth of this circumpyloric furrow. The result referred to is obliteration, partial or complete, of the pylorus and its landmarks, rendering it difficult to decide at a glance whether the ulcer which is being dealt with is duodenal or gastric in origin. An ulcer of this kind is usually classed as "pyloric," which suggests that it has arisen from the stomach. The writer's belief is that a large proportion of such ulcers are truly duodenal and have originated in the duodeno-pyloric fornix. In support of this statement we may turn to the sites of election of chronic gastric and duodenal ulcer. The chronic ulcer of the stomach rarely involves the pyloric canal; it is usually found on the lesser curvature at the lower end of the gastric canal<sup>12</sup> at some distance from the pylorus.† This is in marked contrast with duodenal ulcer, which is rarely found further than one and one-half inches from that structure, and this last it may frequently involve. Laroque<sup>8</sup> has expressed the belief that ulcer on the gastric side of the pylorus is perhaps a later development of duodenal ulcer. Graham's statistics, drawn from a large number of cases, show that the pylorus is involved more than twice as often by duodenal ulcer as by gastric.<sup>22</sup>

Several instances of duodenal ulcer becoming malignant after extending into the stomach are now on record. Perhaps the most interesting are Sherren's two cases in which the duodenal portion of the ulcer

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† Walker<sup>14</sup> in a recent study has recorded 42 perforated gastric ulcers, all within 1½ inches of the pyloric. Most of these must, therefore, have been in the pyloric canal. This is a rather unique finding (compare, for instance, the similar studies of Percy Sargent, St. Thomas's Hospital Reports, 1904, and of John Morley, Practitioner, London, 1913).

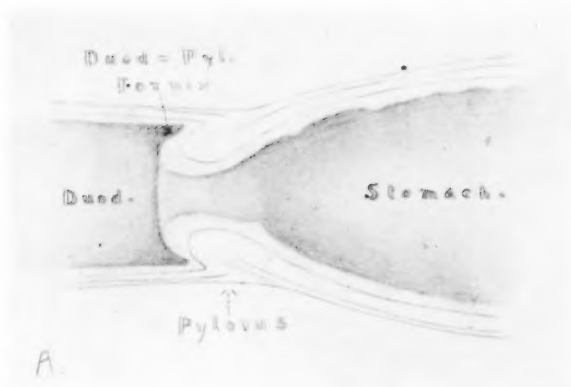


FIG. 1.—A. Horizontal section of the pars pylorica ventriculi and of the duodenum, to show the duodenopyloric fornix. B. Three-quarter end view of the proximal duodenum and the stomach, showing an ulcer in the duodenopyloric fornix. C. The pyloric veins, to illustrate how their short, stubby appearance is due to their disappearance beneath the ligamentum ventriculi or pylori. Drawn from specimens in the author's possession.





## ULCER OF THE DUODENOPYLORIC FORNIX

had quite healed, whilst the gastric part had undergone carcinomatous metaplasia.<sup>18</sup>

*The Pyloric Veins and the Duodenopyloric Fornix.*—The value of an efficient orientating mark for the pylorus is well illustrated by the Mayo Clinic statistics which, with improved methods, have undergone a complete reversal. For whereas gastric ulcer was formerly supposed to be commoner than duodenal, they now see only one of the former to three of the latter. § Obliteration of the pyloric veins will very readily be brought about by an ulcer in the duodenopyloric fornix, particularly by one occupying an anterosuperior position, where it will underlie the superior vein—the more readily seen—and eventually destroy it. The value of these veins as landmarks is undoubted (the statements of Houdard<sup>18</sup> and Hartmann and Lecène<sup>19</sup> notwithstanding). The veins are four in number, two in front, two behind, above and below. Of these only the anterior are of practical value. A single vein, as described by Moynihan (*loc. cit.*, p. 265) and in the early paper of W. J. Mayo,<sup>20</sup> is not common. The later figures of the latter are much more accurate (Fig. 1<sup>18</sup>).

The veins are short and end rather suddenly by dipping beneath the external longitudinal muscle-coat, which here forms a specialized thickened band sometimes called the "ligamentum ventriculi" or "ligamentum pylori" (Fig. 1C). The veins are occasionally joined together by a superficial branch (Moynihan's pyloric vein) which courses over the ligamentum ventriculi, but as their chief object is to carry away blood from the gastric wall the main portions of the veins rapidly disappear from sight. The writer's own dissections, an account of which will appear later, have convinced him of the value of these veins as a surface marking, as it were, for the pylorus. What appears to be one vein on dissection proves to be many small branches, one of which is frequently seen passing through the fibrous ring which separates the circular muscle of the duodenum from the sphincter pylori. These vessels are so placed that a needle thrust through the wall of the duodenopyloric fornix would, as a rule, pierce them. It will be readily seen, therefore, how easily the pyloric veins may be involved by ulceration in this region. From the propinquity of an ulcer in this situation to the sphincteric fibres of the pylorus and the inevitable implication of the latter as the ulcer deepens and spreads, severe pain from pyloro-

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§ The figures of most other clinics agree in the main with these: Peck,<sup>9</sup> 73.3 per cent. duodenal, 26.7 per cent. gastric; Graham,<sup>18</sup> 74.3 per cent. duodenal, 25.7 per cent. gastric; Sherren's<sup>21</sup> figures are more evenly balanced, with 51.5 per cent. duodenal to 48.5 per cent. gastric.

spasm might be expected before fibrosis has progressed far enough to hinder contraction, though the writer has no personal observations on this point.

It was not until after this paper was written that the author became acquainted with a very valuable paper by Codman, bearing on this subject.<sup>21</sup> Codman, in a plea (which deserves much attention) for the correct differentiation of ulcers in the region of the pylorus, describes and illustrates how the pyloric ring may become invaded and destroyed by simple duodenal ulcerations.

#### CONCLUSIONS

1. Ulcer in the duodenopyloric fornix is very favorably situated for the obliteration, partial or complete, of the pylorus and its landmarks, the pyloric veins.

2. Difficulty may then arise in ascribing the ulcer to its correct source. Such an ulcer is usually described as "pyloric," which suggests that it is of gastric origin instead of duodenal.

3. Given a well-marked fornix, such as is likely to be present with a hypertonic stomach, an ulcer may be more or less hidden from view by the projecting pylorus, even after the duodenum has been opened.

#### BIBLIOGRAPHY

- <sup>1</sup> Moynihan, Sir Berkeley: *Duodenal Ulcer*, 2nd edition, London, 1912.
- <sup>2</sup> Paterson, H. J.: *The Surgery of the Stomach*, London, 1913.
- <sup>3</sup> Bolton, Charles: Recent Observations on the Pathology of Ulcer of the Stomach, with Indications for Treatment. *Brit. Med. Journ.*, 1, 1915, p. 707.
- <sup>4</sup> Cunningham, D. J.: The Varying Form of the Stomach in Man and the Anthropoid Ape. *Trans. Roy. Soc. Edinburgh*, vol. 45, 1906.
- <sup>5</sup> Truesdale, P. E.: The Pylorus: Observations upon Its Musculature. *Surgery, Gynecology and Obstetrics*, September, 1915.
- <sup>6</sup> Dwight (quoted by Todd, Wingate): *The Clinical Anatomy of the Gastro-intestinal Tract*. Manchester University Press, 1915.
- <sup>7</sup> Cole, Lewis Gregory: The Diagnosis of Postpyloric (Duodenal) Ulcer. *Lancet*, London, May, 1914.
- <sup>8</sup> Laroque, Paul: Some Anatomic and Physiologic Principles Concerning Pyloric Ulcer. *ANNALS OF SURGERY*, lviii, 1913, p. 321.
- <sup>9</sup> Peck, C. H.: Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, 1915.
- <sup>10</sup> Wilkie, D. P. D.: The Blood Supply of the Duodenum, with Special Reference to the Supraduodenal Artery. *Surgery, Gynecology and Obstetrics*, xiii, 1911, p. 399.
- <sup>11</sup> Wilkie, D. P. D.: Duodenal Diverticula and Duplication of the Duodenal Wall. *Edinburgh Med. Journal*, 1913.
- <sup>12</sup> Jefferson, Geoffrey: The Human Stomach and the Canalis Gastricus (Lewis). *Journ. of Anat. and Phys.*, January, 1915; see also, A Note on the Passage of Fluid Through the Body of the Human Stomach. *Arch. of Röntgen Ray*, March, 1915.

## ULCER OF THE DUODENOPYLORIC FORNIX

- <sup>13</sup> Mayo, W. J.: Chronic Duodenal Ulcer. *Journ. Amer. Med. Assoc.*, June, 1915.
- <sup>14</sup> Walker, I. J.: Acute Perforation of Ulcers of the Stomach and Duodenum. *Boston Med. and Surgical Journal*, clxxiii, 1915, p. 451.
- <sup>15</sup> Sherren, James: A Contribution to the Discussion on the Choice of Operation in Chronic Gastric and Duodenal Ulcer. *Surgery, Gynæcology and Obstetrics*, xix, 1914, p. 564.
- <sup>16</sup> Graham, C.: Notes on Gastric and Duodenal Ulcer. *Trans. Marshfield Clinical Meeting, Marshfield, Wis.*, 1915; *Surgery, Gynæcology and Obstetrics, International Abstract of Surgery*, September, 1915, p. 262.
- <sup>17</sup> Sherren, James: Diagnose und chirurgische Behandlung des Magen und Duodenalgerchwürs. *Berliner klinisch Wochensch.*, 1, 1913.
- <sup>18</sup> Houdard: L'ulcère simple du duodenum, non perforé. *Thèse de doct., Paris*, January, 1913.
- <sup>19</sup> Hartmann, H., and Lecène, P.: Ulcer of the Stomach and of the Duodenum. *ANNALS OF SURGERY*, August, 1914.
- <sup>20</sup> Mayo, W. J.: A Better Understanding of the Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, June, 1907.
- <sup>21</sup> Codman, E. A.: On the Importance of Distinguishing Ulcer of the Duodenum from those Ulcers which Involve the Pylorus or Are Above It. *Boston Medical and Surgical Journal*, clxi, 1909, p. 313.
- <sup>22</sup> Graham, C.: Observations on Peptic Ulcers. *Boston Medical and Surgical Journ.*, 1914, clxx.

## CYSTIC DILATATION OF THE VERMIFORM APPENDIX

REPORT OF A CASE OF HYDROPIIC CYST, WITH A STUDY OF 142 CASES

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THIS infrequent condition has been designated variously as retention cyst, hydrops, mucocele, colloid cyst, pseudomucous cyst of the appendix, and cystic disease of the appendix. Virchow first described the condition in 1863. Rokintansky in 1867 described four cysts which he considered examples of colloid carcinoma. A number of later writers have expressed doubt as to the neoplastic character of these tumors. Feré in 1877 described a specimen found at autopsy which he designated as a mucocele. Wölfler in 1879 was the first to report the occurrence of an appendiceal cyst in a hernial sac. In 1880 Wier exhibited a case in which an incision had been made over the tumor and drainage instituted. He regarded the condition as an appendiceal cyst, and recalled a case he had seen in Bellevue Hospital two years previously, that had been similarly drained and had healed. In 1887 Vimont reported a cyst which he referred to as a mucocele. During the following two decades many important contributions were made to the subject. Among these may be mentioned the papers of Guttman 1891, Ribbert 1893, Van Hook 1896, Stengel 1906, Corning 1906, McConnell 1907, and J. A. Kelly in 1909. Van Hook collected 33 examples of cysts from the literature, including his own case, which occurred in a hernial sac. Kelly tabulated 68 cases. Crouse in 1910, in a general study of appendiceal tumors, tabulated a total of 89 cysts, including the material of Kelly and Van Hook.

*Frequency.*—Castle has cited recently the autopsy records of Ribbert, Bryant, Steiner, Boody, Kelly and Hurdon, Stengel, Heineck and Castle, a total of 13,158 autopsies, and found a total of 28 cases or about 0.2 per cent.

Corning, out of 935 appendices sent to his laboratory from the operating room, found only 5 cysts, 0.68 per cent.

After a rather extended search of the literature and a careful examination of the material in Van Hook's, J. A. Kelly's and Crouse's tables, and after rejecting a few cases evidently not appendiceal cysts and adding a number of cases not previously listed, the writer is able to collect a total of only 142 cases. Of these 55 are reported from

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autopsies, 66 from operations, and in 21 cases the information was not recorded or was not accessible.

*Incidence.*—In these cases 37 were in males, 34 in females, and in 71 the sex was not recorded.

The age incidence was as follows:

	Operation	Autopsy	Combined
1-10 years .....	0	0	0
11-20 years .....	6	2	8
21-30 years .....	6	4	10
31-40 years .....	7	0	7
41-50 years .....	5	2	7
51-60 years .....	3	4	7
61-70 years .....	3	5	8
71-80 years .....	1	3	4
81-90 years .....	0	1	1

Age not recorded in 88 cases.

In the operative cases 34 were found at operations for appendicitis or for acute or chronic disturbances connected with the right iliac region with or without a diagnosis; 15 during the course of operations on other organs. In 17 cases records were inconclusive.

*Etiology.*—As recognized etiological factors may be mentioned: (a) The so-called normal involution or obliterative process (now believed by most pathologists to be inflammatory) occurring in such manner that occlusion takes place at some point between a secreting area and the base of the appendix; (b) general proliferative and ulcerative inflammatory processes; also, possibly, (c) specific infections, as typhoid, tuberculosis and syphilis; and, possibly, (d) malignant changes. As occasional and contributory causes may be mentioned angulation, torsion and compression of the lumen by external adhesions. Habitual distention of the cæcum causing closure of Gerlach's valve has also been suggested as a factor.

Out of 142 cases, evidences of chronic inflammation were definitely recorded in 45 cases.

Typhoid ulceration was given as a possible factor in 1 case (Castle).

Tubercular lesions were present in the cæcum and appendix in 1 case (Wenzel-Gruber).

In the case reported by Lilienthal syphilitic infection had been present during the month preceding the operation, in which period alone the patient suffered from appendiceal symptoms; but whether the luetic process had been present long enough to have induced cyst formation is somewhat doubtful.

Garrow and Keenan report a case in which the occluding nodule, at



first thought to be inflammatory, disclosed itself on microscopic section to be a cubical-celled carcinoma invading all of the coats of the appendix.

Landenberger reports a case where two very severe concussive injuries initiated symptoms that led to operation eleven months later. There were no adhesions or evidences of inflammatory processes outside of the appendix, but the lumen was obliterated. There was no histopathic report. This traumatic history is paralleled somewhat by that given in Neumann's case.

It is evident from a study of appendiceal cysts that they are due to the retention of normal or altered products of secretion, to which may be added later the products of disintegration and degeneration. The immediately correlated factors are secretion, resorption and usually a more or less complete occlusion of the lumen. Secretion on the one hand must be in excess of resorption and discharge on the other.

Out of 37 cases studied in which the condition of the lumen was definitely described, in 26 the lumen was completely obliterated and in 5 was nearly or partially obliterated.

That complete or partial obliteration of the lumen is not essential in all cases is shown by the records of 5 otherwise typical cases in which the lumen is recorded as distinctly patent. In all the cases, however, in which the lumen is recorded as free, the contents are described as very thick and tenacious.

It is quite probable that in these cases the action of the muscularis is inefficient (Latham) or its structure impaired. In only one of these cases with open lumen do we have a record of the condition of the muscularis, that of Phemister, and in this case it is completely absent.

The absence of infective organisms from the involved portion of the lumen may be considered as a necessary condition for cyst development. In the six cases in which infection was present, empyemata, the specimens were all small in size.

Phemister has made some interesting attempts to produce cyst formation experimentally in dogs, by artificial obliteration of the appendix lumen. The results, however, were unsatisfactory. In all the cases but one, gangrenous appendicitis supervened. In the single case where this complication was avoided, the appendix lumen became restored.

*Pathology.—Size:* In 51 cases the size of the cyst was small, up to 3 cm. in length; in 33 cases it was medium,  $3\frac{1}{2}$  to 9 cm.; and in 11 cases the size ranged from 9 cm. up. In 47 cases the size was not accurately recorded.

The largest specimens of which we have an account are probably

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that of Neumann, disclosed at operation on a man aged sixty-nine, and described as being as large as a man's head; that described by Guttman, found at autopsy on a woman aged seventy, pear-shaped, 14 cm. long and 21 cm. in its greatest circumference; and that of J. A. Kelly, found at autopsy, the size and shape of a very large banana, curved at its base into a hook shape, and 30 cm. long on its greatest curvature and with a greater circumference of 15 cm. Wood's specimen, removed at operation from a woman aged fifty-two, was sausage-shaped, 20 cm. in its greatest length and had a diameter of 7 cm. Phemister's specimen removed at operation from a middle-aged woman was 17 cm. in length and its greatest circumference was 21 cm. Noble's specimen, also removed at operation, had a length of  $7\frac{3}{4}$  inches and a circumference at its distal end of  $5\frac{3}{4}$  inches.

It will be noted that the largest two specimens were found in subjects in advanced life, while the two next larger ones occurred in subjects around middle age.

*Shape:* Perhaps the largest number of medium-sized and large cysts have been described as sausage-shaped or banana-shaped and as pear-shaped. They have been described also as comma-shaped, sigmoid and globular. Many of the smaller cysts have been described as fusiform, sacculated, and egg-shaped. They may be found occupying any portion of the lumen of the appendix.

The entire appendix was involved in 23 cases; a portion of the appendix in 38 cases; the site was not definitely recorded in 81 cases.

*Contents:* In 59 cases the contents were described as either mucoid, colloid, gelatinous or pseudomyxomatous; in 13 cases they were described as watery, liquid, or serous (hydrops); in 6 cases as purulent; in 1 case the contents were described as putty-like; 2 cases showed dark areas of extravasated blood; and 2 cases, those of Latham and Cagnetto, showed the gelatinous contents arranged in a mass of small, shot-like bodies; gaseous frothy contents were found in Gildersleeve's case.

A yellowish or grayish color is usually ascribed to the contents of these cysts.

The character of the cyst contents seems to vary with the condition of the mucous membrane and the degree of change taking place in the cyst walls. It is probable that the secretion is at first always mucoid; and in connection with this condition there may be thickening of the mucous and muscular coats. Later on, as the effects of continued pressure make themselves evident on the cyst walls, there are added further products of hyaline or myxomatous degeneration of fibrous elements,

possibly lending a gelatinous character to the contents. These changes may take place in varying degrees in different parts of the cyst wall so that the continuous addition of mucous elements may take place parallel with gelatinous changes, and this may in a measure account for the arrangement of the contents as well as the great quantity of material at times accumulated.

*Adhesions* were not noted as often as might be expected. They are recorded as being present in 13 cases; as absent in 7 cases; and are not recorded in 122 cases.

*Diverticula* of various sizes are described either as protrusions from the walls of an already well-defined cyst or as springing from any portion of the wall of the dilated appendix. They are especially noted 12 times in this series. But the smaller forms of diverticula are probably much more frequent. They are seen as evaginations on the surface of many of the larger cysts.

Ribbert was the first to describe this condition. In his opinion it usually is due to protrusion of the mucosa through the thinned or partially destroyed muscularis. In some cases he thinks they may be due to cystic degeneration of the glands of the mucosa. Oberndorfer thinks that these processes have their origin in ulcerated areas in the mucosa and Crowell demonstrates this condition in his specimen.

Foreign writers have used the term "hydrops" rather loosely. True hydrops is really a rare condition occurring in only about 9 per cent. of all cysts tabulated. According to Leube it is the result of advanced pressure changes on the thinning walls, bringing the blood-vessels of the submucosa into a more superficial relation to the surface and allowing a transudate of the more fluid portions of the blood. There is further a lessened production of mucus due to atrophy of the mucosa. Complete occlusion of the lumen would seem a necessary accompaniment to the condition. In the 6 examples of this condition in which the state of the lumen is recorded it is described as completely closed.

*Histopathology.*—Where the walls of the appendix outside the area of cyst formation have been studied they have usually shown the evidences of acute and chronic inflammatory change, thickening, ulceration, round-celled infiltration and connective-tissue proliferation. The lumen may be in a state of complete or partial obliteration or may be patent.

The walls of the cysts show in general the changes due to inflammation and pressure. The mucosa may be more or less uniformly thinned, it may disclose areas of ulceration and infiltration, it may be

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absent in places, or it may be completely destroyed. On its surface at times may be seen secreting and disintegrating cells, and platelets of lime salts may be adherent. The muscularis mucosæ may be hypertrophied or later replaced by fibrous elements. The changes in the submucosa correspond in general to those in the mucosa. It may show flattened and atrophic lymph follicles. The muscular coat may show great thickening in the early stages of cyst formation, as shown in many of the smaller specimens. Later it becomes greatly thinned or else completely replaced by fibrous tissue. The serous coat at first shows hyperplasia of blood-vessels; later they may become greatly attenuated. Fibrous thickening may take place.

Ogilvie has reported a case recently in which nearly the entire wall of the cyst was replaced by lime salts.

The cyst contents may be amorphous or when of thick consistence often will show a lamellated structure; and a striated, fibrillar or reticulated arrangement may be distinguished at times, either alone or in combination with lamellation. These fibrils apparently result from degenerative processes in the connective tissue. Degenerated cellular elements at times may be observed and occasionally pigmented areas, the result of disintegration of red blood-cells. Scattered platelets of lime salts not infrequently are found throughout the mass and occasionally fatty crystals and cholesterin.

*Chemical Examination.*—In only 6 cases are the results of chemical examination of cyst contents definitely recorded. In 3 the reaction was stated as mucin; in 2 as pseudomucin; and in 1 as colloid.

*Symptoms.*—A study of the records of operative cases shows appendiceal symptoms to have been present more frequently than has been supposed by many writers.

In 66 operative cases a history of pain, discomfort or other symptoms referable to the right iliac fossa was recorded in 34 cases, 51 per cent.; symptoms were either absent or obscured by other conditions in 14 cases; they were not recorded in 18 cases.

Autopsy records in the past have been too deficient in respect to clinical data to form a fair basis for the estimation of the frequency of symptoms.

In 55 autopsy cases symptoms were noted as absent in 3 cases; present in 1 case; and not recorded in 51 cases.

*Diagnosis.*—In no case was a diagnosis made or suggested previous to operation with the single exception of Ogilvie's case, an easily palpable calcareous cyst, in which the diagnosis lay between a calcareous cyst of the appendix and a ureteral calculus. In 13 cases the diagnosis

of chronic appendicitis was definitely made. In one case the diagnosis of acute appendicitis was made. In 6 cases the operation was done for acute or chronic abdominal symptoms, more or less referable to the right iliac fossa, but without diagnosis.

In Phemister's and Wilson's cases the diagnosis had been that of ovarian cyst.

In Hartman and Kindley's case the diagnosis of floating kidney had been twice made and a fixation operation performed previously. At the second operation the incision was extended and the true nature of the condition discovered.

Weinhold removed a pedunculated cyst from a woman aged seventy-four, on whom he had made the diagnosis of a pedunculated uterine fibroid.

The diagnosis of probable new growth of the intestines was made in Crawford's case, the patient being a man of sixty-three with tumor and beginning obstructive symptoms.

In Neumann's case, a subject with a traumatic history was operated upon with a diagnosis of probable infected hæmatoma.

*Prognosis.*—As would be expected the course following the removal of these simple cysts has been uniformly favorable.

*Complications.—Infections:* The clinical occurrence of acute pyogenic processes has been noted. In Lilienthal's case, healing of the abdominal wound would not take place until syphilitic treatment had been instituted.

*Occurrence in hernial sacs:* Three cases of this condition have been reported, those of Wölfler, McArthur and Van Hook.

*Rupture of cyst:* This occurred in Van Hook's case from previous attempts at reduction of the hernial sac. In one of Wilson's cases it resulted from a very gentle bimanual examination.

Lubarsch, Roberg, and Fränkel record the spontaneous rupture or perforation of the cyst with extravasation of portions of the contents into the peritoneal cavity and the formation of pseudomyxomatous masses. In Moore's case in which the peritoneum was similarly involved, the appendix was disintegrated, and in Trotter's case it could not be found.

*Pseudomyxoma peritonei:* The last group of cases brings into consideration this interesting condition. It is a well-recognized clinical phenomenon that under certain conditions the contents of appendiceal cysts, like those of certain ovarian cysts, are capable of causing proliferation when implanted upon the surface of the peritoneum. The condition has been studied by Werthe, Lubarsch, Wilson, Trotter,



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McConnell and others. Werthe first showed the condition to be one of inflammatory reaction of the peritoneal cells. Wilson claims that metastases such as occur in ovarian pseudomyxomata have not been observed in appendiceal cases as yet. And Trotter, in this connection, says that the cubical and columnar cells described in the gelatinous contents by different observers, and attributed by some to proliferation of the epithelial cells of the appendix, are more probably due to transformation of the peritoneal endothelium. Lubarsch and McConnell, from a study of their own specimens and those of Rokitsansky, Draper, Vimont, Baillet and Stengel, are inclined to the view that there is an actual transference and proliferation of the cells of the appendiceal mucosa, and to regard such cases as true adenocystomata.

The writer has been able to collect 14 reported examples of pseudomyxoma peritonei, those of Fränkel, Merkel, Lubarsch, Oberndorfer, Hüter, McConnell, Roberg, Neumann, Moore, Cramer, Eden, Wilson, Rathe and Hammesfahr. Nager's case was described by him as a lymphangio-endothelioma, but Neumann considered it to be an example of pseudomyxoma peritonei.

*Carcinoma.*—Stengel has made a careful study of the histopathic character of the cases reported by Rokitsansky. They would seem to have had no additional heterotopic features to the cases which Lubarsch and McConnell have classed as adenocystomata. In common with these cases they appear to have lacked the general clinical aspects of malignant disease and showed no tendency to metastases.

In 1884, DRAPER reported a case found at autopsy in a sixty-five-year-old man in whom death was apparently due to the condition in the cæcum and appendix. Draper described the condition as colloid carcinoma. The base of the appendix was dilated into a thick-walled cyst communicating freely with the cæcum. He described the irregular, infected, thickened wall of the cyst as having the characteristic appearance of colloid disease. There was no histopathic report.

In 1913 ELTING reported a case observed at autopsy in a male aged eighty-one. The cyst was  $5\frac{1}{2}$  cm. long and 3 cm. in diameter, and filled with a yellowish-green, transparent gelatinous material, presenting a striated and lamellated appearance and which protruded from a perforation in the wall. The mucosa had apparently disappeared. The submucosa and muscularis were found to be invaded by a new growth, composed of glandular structures closely arranged with very little stroma. Diagnosis: Primary adenocarcinoma of the appendix, belonging to the type which is generally known as colloid carcinoma.

ROBERG's case has been previously cited. He was at first inclined to regard it as one of colloid carcinoma but on further study placed it in the class of pseudomyxoma peritonei.

In 1903 NORRIS reported a case of primary carcinoma of the appendix removed at operation. The patient was well 8 months after operation. The cystic character of this specimen was not conspicuous.

More recently McWilliams has tabulated 3 cases of carcinoma occurring in cysts those of Jong, Landau and Pauchet. MacCarty and McGrath have tabulated 2 cases, and Garrow and Keenan 1 case. In Jong's case the condition was recorded as a spheroidal-celled carcinoma; the meso-appendix was not involved and the patient was reported well after two years. Landau's case was described as a spheroidal-celled carcinoma and the meso-appendix was not involved. Pauchet's case was designated columnar-celled; the meso-appendix was not involved; the pedicle was twisted.

Chronic inflammatory lesions were recorded in two of McWilliams's cases. and in MacCarty's and McGrath's cases the condition was secondary to inflammatory processes. Garrow and Keenan describe the condition in their case as primary.

*Report of Case of Hydropic Cyst.*—Patient is a pale, well-developed, but rather poorly nourished man, aged twenty-nine. Thinks he had no more abdominal disturbance in childhood than is usual with children, but always suffered from constipation, and when a boy had two attacks of pain in the abdomen that required a physician's services. One year ago had a severe attack of pain in the right inguinal region that continued with more or less discomfort for one month. One month ago had another severe attack, confining him to bed for one week and having the general character of an acute appendiceal exacerbation. Has had 6 or 7 attacks in all in the past year, and since the last attack his bowels have been very hard to move, and discomfort has been nearly constant. *Diagnosis:* Chronic appendicitis.

*Operation* (February 11, 1915).—One month after last attack. Through a rectus incision the appendix presented itself as a grayish-white, tense and very thin tumor the size and shape of a breakfast sausage. It was attached to the base of the cæcum by a narrow cord about 1 cm. long. The base was free but the outer half was rather firmly adherent to the cæcum, the parietal peritoneum and a coil of small intestine. These adhesions required to be freed with some care to avoid rupturing the cyst. The pedicle was ligated and the tumor removed. Recovery was uneventful.

*Pathological Report.*—Gross examination shows a grayish-white, tense, thin-walled, somewhat sausage-shaped cyst. A few fine blood-vessels are seen branching on its surface. It measures  $10\frac{1}{2}$  cm. in length. Its width is 3 cm. at the base and it tapers slightly toward the distal end. The outer cyst wall shows a number of small nodular projections on its surface. The inner wall is quite smooth and shows diverticula or evaginations corresponding to the external projections. The cyst wall is of paper thinness and transparent throughout. The fluid removed from the cyst measures 30 c.c. It is thin, watery and slightly opalescent and contains a few flakes of fibrin.

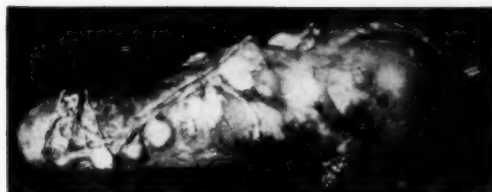


FIG. 1.—Hydropic cyst of the appendix (reduced one-half). Removed at operation. Length  $10\frac{1}{2}$  cm. Greatest diameter 3 cm. Three small diverticula are seen near the distal mesenteric attachment.

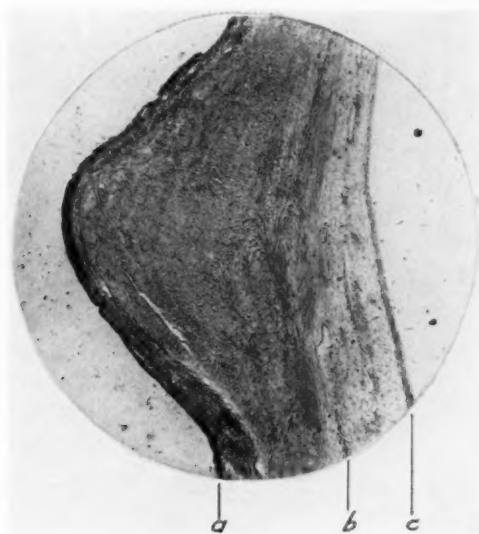
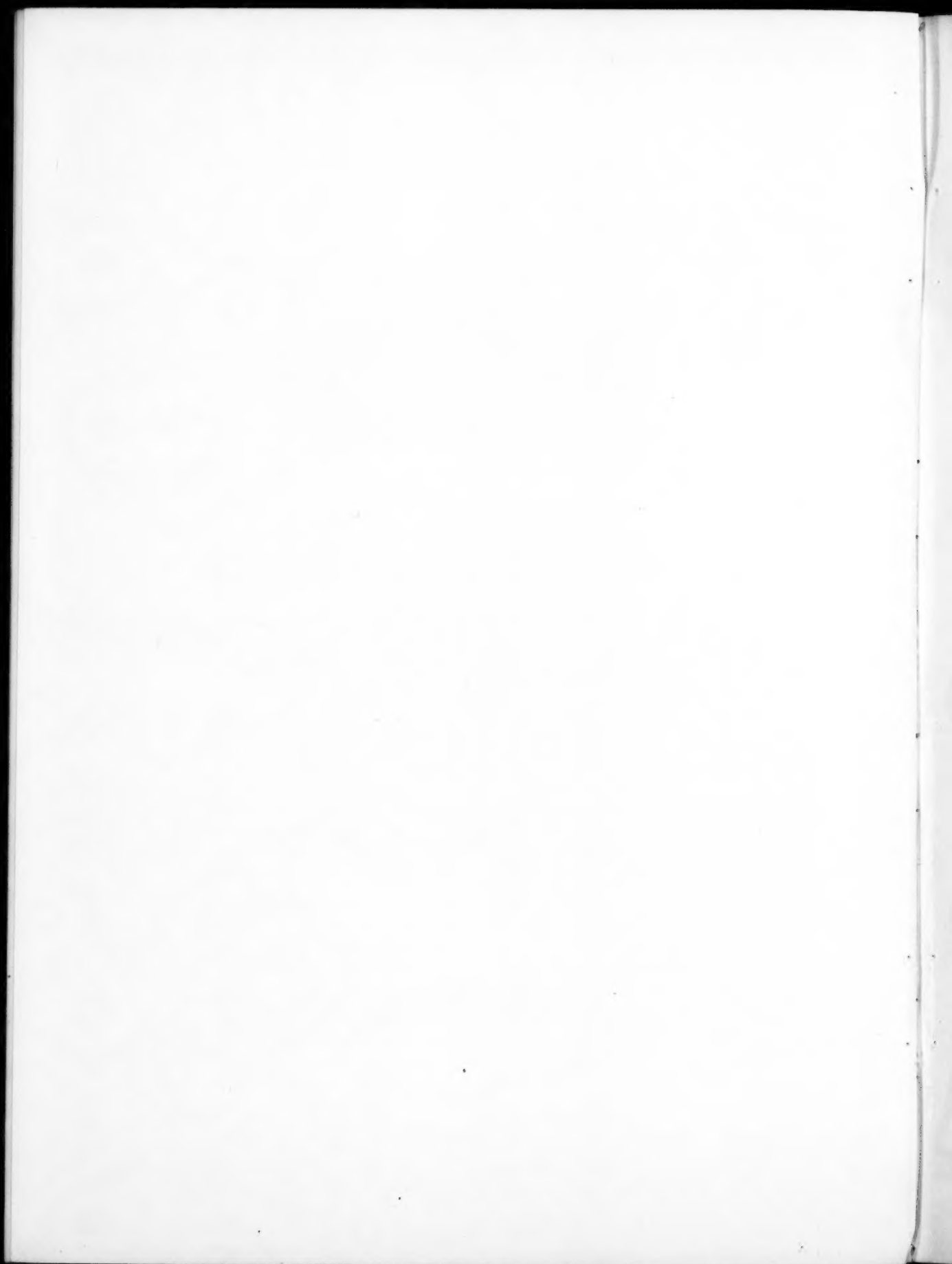


FIG. 2.—Section of the cyst wall, showing, *a*, the remains of the mucosa; *b*, the greatly attenuated muscularis; *c*, the serosa.



## CYSTIC DILATATION OF THE VERMIFORM APPENDIX

Microscopic examination of sections of the pedicle of this tumor, the original base of the appendix, shows it to be merely a fibrous band with no lumen.

Sections of the cyst wall reveal only a thin layer of epithelial cells, representing the remains of the mucosa. The muscularis is greatly attenuated and fibrous. There is considerable round-celled infiltration in places. The serosa is thickened and fibrous.

*Chemical examination* of the cyst fluid was inconclusive, owing possibly to the presence of preservative.

*Condensed Table of Cases and Literature.*—In the original tabulation the following factors were considered: Source of case; history; age; sex; diagnosis; complications; general conditions present, size, shape and contents of cyst, state of lumen and portion of appendix involved; presence of adhesions; presence of diverticula; microscopic examination of appendix wall, cyst wall and contents; chemical examination of contents. In a few cases the original articles were not accessible and the descriptions of other authors were utilized.

### CONCLUSIONS

1. That cystic dilatation of the appendix is a relatively infrequent condition.
2. That true hydrops of the appendix is rare. Probably less than 9 per cent. of all appendiceal cysts.
3. That appendix cysts are essentially retention cysts and of inflammatory origin.
4. That the condition by no means runs a symptomless course; symptoms being present in at least 51 per cent. of operative cases, and 24 per cent. of all cases.
5. That the contents of certain appendiceal cysts, when implanted upon the peritoneal surface, are capable of producing a condition of pseudomyxoma peritonei.
6. That certain appendiceal cysts present structural and clinical characters that seem to ally them with adenocystomata.
7. That carcinomatous changes occasionally take place in appendiceal cysts.

I wish to express my thanks to Dr. Philip Hillkowitz of Denver, Colo., for the pathological examination of the specimen and the preparation of sections and to Dr. A. J. Markley of Denver for the microphotograph.



No.	Author	Source	Sex	Age	Reference	Condition
1	Baillet.....	Op.	F.	..	Bull. de la Soc. Anat. de Paris, 1891, v, 66, p. 67	Mucous cyst.
2	Baldwin.....	Op.	F.	40	Brooklyn Med. Jour., June, 1904.....	Gelatinous cyst.
3	Barber.....	Op.	..	..	Referred to by Baldwin.....	Gelatinous cyst.
4	Berry.....	Aut.	..	..	Journ. of Path., April, 1895.....	Mucous cyst.
5	Bierhof.....	Aut.	M.	77	Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248..	Small mucous cyst.
6	Bierhof.....	Aut.	..	..	Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248..	Small cyst, serous contents.
7	Bierhof.....	Aut.	..	..	Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248..	Mucous cyst.
8	Bierhof.....	Op.	..	..	Discussion of Stengel's case.....	Mucous cyst.
9	Biggs.....	Aut.	..	..	Med. Rec., vol. 43, p. 536.....	Mucous cyst.
10	Boody.....	Aut.	..	..	Med. Rec., vol. 43, p. 536.....	Strictured appendix.
11	Cagnetto.....	Aut.	F.	70	Am. Med., August 16, 1902, p. 202.....	Liquid contents.
12	Castle.....	Op.	M.	33	Virchow's Archiv, Bd. 198, H. 2, s. 193.....	Gelatinous cyst.
13	Chevrier.....	Op.	M.	30	ANNALS OF SURGERY, May, 1915, p. 582.....	Gelatinous cyst.
14	Combermale.....	Op.	..	..	La Revue Méd. du Canada, 1903-1904, p. 15..	Small serous cyst.
15	Combermale.....	Aut.	..	..	Bull. Méd. du Nord, 1891, p. 223.....	Designated hydriops.
16	Coats.....	Aut.	..	..	Bull. Méd. du Nord, 1891, p. 223.....	Designated hydriops.
17	Coats (from Stengel).....	Aut.	..	..	Glasgow Med. Jour., 1875, p. 126.....	Tip of appendix.
18	Corning.....	Op.	M.	16	Cited by Kelyack. Manual of Path., 2d Ed., p. 173	Gelatinous cyst.
19	Corning.....	Op.	F.	50	Albany Med. Annals, December, 1905, xxvi.....	Gelatinous cyst.
20	Corning.....	Op.	M.	36	Albany Med. Annals, December, 1905, xxvi.....	Described as colloid.
21	Corning.....	Op.	F.	60	Albany Med. Annals, December, 1905, xxvi.....	Gelatinous cyst.
22	Cramer.....	..	F.	..	Trans. Gyn. Soc., Chicago, 1911, p. 373.....	Gelatinous cyst. Pseudomyxoma peritonei.
23	Crawford.....	Op.	M.	63	Iowa Med. Jour., September, 1909, p. 129.....	Character of contents not stated.
24	Crouse.....	..	..	..	Surg., Gyn. and Obs., November, 1910, p. 457..	Cases noted separately.
25	Crowell.....	Aut.	M.	40	Philippine Jour. of Science, February, 1912.....	Gelatinous cyst.
26	Deaver.....	Aut.	F.	..	Treatise on Appendicitis, Philadelphia, 1900.....	Mucous cyst; size of orange.
27	Dodge.....	Op.	M.	29	Described in this paper.....	Hydropic cyst.
28	Draper.....	Op.	M.	65	Bost. Med. and Surg. Jour., 1884, 110, vi, p. 131.	Colloid carcinoma.
	Eden.....	Op.	F.	..	Lancet, 1912, p. 1498.....	Gelatinous cyst. Pseudomyxoma peritonei.

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29	Elting.....	Aut.	M.	81	ANNALS OF SURGERY, 1903, xxxvii, p. 549.....	Colloid carcinoma.
30	Fenwick.....	..	..	..	Cited by Kelyack.....	Milky contents; a hydrops.
31	Féré.....	Aut.	M.	55	Le Prog. Méd., Paris, 1877, vol. 5, p. 73.....	"Mucocele."
32	Finklestein.....	..	..	..	Described under Guttman.....	..
33	Forster.....	..	..	..	Cited by Wolfier as having had a case. Reference not given.	..
34	Fränkel.....	Aut.	M.	79	Münch. Med. Woch., 1901, xxiv, s. 965.....	Pseudomucinous cyst. Pseudo-myxoma peritonei.
35	Garrow and Keenan.....	Op.	F.	21	ANNALS OF SURGERY, October, 1908.....	Cubical-celled carcinoma.
36	Gildersleeve.....	Op.	M.	43	Brooklyn Med. Journ., August, 1904, p. 318.....	Gaseous frothy contents.
37	Glassmacher.....	..	..	..	Cited by Van Hook.....	Empyema.
38	Guttman.....	Aut.	F.	70	Deut. Med. Woch., 1891, s. 260.....	Described as a hydrops.
39	Hartman and Kindley.....	Op.	F.	..	Jour. A. M. A., 1904, p. 1795.....	Pseudomucinous cyst.
40	Hawkins.....	..	..	..	Diseases of Verm. Appendix, London, 1895.....	Empyema.
41	Hawkins (from Stengel).....	..	..	..	Diseases of Verm. Appendix, London, 1895.....	Empyema.
42	Hämmesfahr.....	Op.	F.	..	Deut. Med. Woch., July 31, 1913.....	Pseudomucinous cyst.
43	Hämmesfahr.....	Op.	F.	..	Deut. Med. Woch., July 31, 1913.....	Pseudomucinous cyst. Pseudo-myxoma peritonei.
44	Heckteon.....	..	..	..	Described under Jaggard.....	Large diverticulum.
45	Herb.....	Aut.	..	..	Tr. Chic. Path. Soc., 1907.....	Mucous cyst. Possible pseudo-myxoma peritonei.
46	Hirst.....	Op.	..	..	Referred to by Stengel.....	Gelatinous cyst. Pseudomyxoma peritonei.
47	Hueter.....	..	..	..	Ziegler's Beitrage, 1907, Bd. 41, s. 517.....	Empyema.
48	Jaggard.....	Op.	F.	47	Am. Jour. Obs., 1893, xxviii, p. 226.....	Spheroidal-celled cancer.
49	Jong.....	Op.	F.	..	Mitt. Aus. d. Grenz d. Med. u. Chir., 1907, xviii, No. 3.....	Large gelatinous cyst.
50	Kelly, J. A.....	Aut.	M.	43	ANNALS OF SURGERY, April, 1909, p. 524.....	All small mucinous or gelatinous cysts.
51	Kelly and Hurdon (16 cases).....	Aut.	..	..	The Verm. Appendix and Its Diseases. Philadelphia and London, 1905, p. 250.....	Gelatinous cyst.
52	Kelyack.....	Aut.	F.	..	The Path. of the Verm. Appendix, London, 1893.....	Mucinous cyst.
53	Kennedy.....	..	..	..	N. Y. Med. Journ., March 22, 1913.....	Small empyema.
54	Klemm.....	Op.	F.	16	Munch. Med. Woch., 1905, No. 4.....	Small empyema.
55	Klemm.....	Op.	M.	37	Munch. Med. Woch., 1905, No. 4.....	Small empyema.
56	Klemm.....	Op.	M.	26	Munch. Med. Woch., 1905, No. 4.....	Small empyema.
57	Klemm.....	Op.	M.	..	Gaz des Hôpitaux, Paris, 1904, lxxvii, p. 33.....	Small granular mucous masses.
58	Lafforgue.....	Aut.	F.	50	Nothnagel's Encl. of Med., New Am. Ed.....	Cyst filled with shot-like bodies.
59	Latham.....	..	..	..	..	..

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No.	Author	Source	Sex	Age	Reference	Condition
73	Landau.....	Op.	F.	33	Ber. Klin. Woch., 1906, December 10.....	Spheroidal-celled cancer.
74	Landenberger.....	Op.	M.	32	N. Y. Med. Rec., 1904, lvi, p. 856.....	Hydrops.
75	Leube.....	Op.	M.	23	Ziemssen's Encyclopedia, vol. vii.....	"Colloid" cyst.
76	Lilienthal.....	Op.	M.	69	N. Y. Med. Jour., 1903, lxxvii, p. 233.....	Pseudomyxoma peritonei.
	Lubarsch.....	Op.	M.		Ergebn. d. Allgem. Path. u. Path. Anat., 1903, vol. xviii, s. 847.....	
77	McArthur.....	Op.	M.	..	Am. Jour. Obs., August, 1893, vol. 28, p. 275.....	Small cyst in hernial sac.
78	McConnell.....	Aut.	M.	50	Internat. Clinics, 1907, vol. 4, Series 17.....	Pseudomyxoma peritonei.
79	MacCarty and McGrath.....	Op.	F.	25	ANNALS OF SURGERY, lix, 1914.....	Carcinoma in chronic cystic appendix.
80	MacCarty and McGrath.....	Op.	F.	36	ANNALS OF SURGERY, lix, 1914.....	Colloid carcinoma.
81	MacLean.....	Op.	M.	20	Munch. Med. Woch., August 18, 1908, s. 1746.....	Emphyema.
	McWilliams.....	Op.	..	..	Am. Journ. Med. Sci., June 16, 1908, p. 822.....	Cases noted separately.
	Matas.....	Op.	..	..	Abs. Jour. A. M. A., 1914, lxii, p. 328.....	Extra-appendiceal condition.
82	Maylard (from Stengel).....	Op.	..	..	Tr. Glasgow Clinic and Path. Soc., 1891, 3, iv, iii.....	Gelatinous cyst.
83	Merkel.....	Aut.	M.	69	Ergebn. d. Allgem. Path. u. Path. Anat., Abt. 2, vol. 9, s. 329.....	Pseudomyxoma peritonei.
84	Montgomery.....	Op.	F.	..	Jour. A. M. A., xxix, p. 172.....	Cyst with staphylococci present.
85	Montgomery.....	Op.	F.	..	Jour. A. M. A., xxix, p. 172.....	Hydrops.
86	Moore.....	Op.	F.	44	Brit. Med. Jour., 1910, vol. 1, p. 1109.....	Pseudomyxoma peritonei.
87	Nager.....	..	..	..	Ziegler's Beitrage, 1904, Bd. 36, H. I., s. 88.....	Described as a lymphangio-endothelioma.
88	Norris.....	Op.	F.	27	Univ. of Pa. Med. Bull., November, 1903, No. 9.....	Primary carcinoma.
89	Neumann.....	Op.	M.	60	Berlin Klin. Woch., January, 1909, No. 1, s. 15.....	Very large pseudomyxomatous cyst
90	Noble.....	Op.	..	..	Jour. A. M. A., March 9, 1912.....	Large cyst; contents not described.
91	Oberndorfer.....	Aut.	M.	69	Verh. der Deut. Path. Ges., 1906, s. 235.....	Small gelatinous cyst.
92	Oberndorfer.....	Aut.	M.	64	Verh. der Deut. Path. Ges., 1906, s. 235.....	Small gelatinous cyst.
93	Oberndorfer.....	Aut.	M.	..	Verh. der Deut. Path. Ges., 1906, s. 235.....	Pseudomyxoma peritonei.
94	Oberndorfer.....	Aut.	M.	74	Verh. der Deut. Path. Ges., 1906, s. 235.....	Small gelatinous cyst.
95	Ogilvie.....	Op.	M.	22	Jour. A. M. A., February 20, 1915, p. 657.....	Pseudomucinous cyst; calcareous walls.
96	Pauchet.....	Op.	..	..	Gaz. Med. de Picardie, 1900, xviii, p. 146.....	Columnar-celled carcinoma.
97	Perkins, I. B.,.....	Op.	F.	15	Personal description.....	Small mucous cyst.

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98	Phemister.....	Op.	F.	..	Jour. A. M. A., May 29, 1915.....	Large pseudomucinous cyst.
99	Rathe.....	Op.	F.	31	Monatsschr. f. Geburtsh. u. Gyn., 1913, vol. 37, s. 322	Gelatinous cyst. Pseudomyxoma peritonei.
100	Ribbert.....	Aut.	F.	30	Virchow's Archiv, 1893, cxxxii, s. 66.....	Small mucous cyst.
101	Ribbert.....	Aut.	M.	19	Virchow's Archiv, 1893, cxxxii, s. 66.....	Small gelatinous cyst.
102	Ribbert.....	Aut.	M.	55	Virchow's Archiv, 1893, cxxxii, s. 66.....	Small gelatinous cyst.
103	Ribbert.....	Aut.	M.	26	Virchow's Archiv, 1893, cxxxii, s. 66.....	Small gelatinous cyst.
104	Ribbert.....	Aut.	M.	70	Virchow's Archiv, 1893, cxxxii, s. 66.....	Small gelatinous cyst.
105	Ribbert.....	Aut.	F.	..	Tr. Chic. Path. Soc., 1908, p. 180.....	Small gelatinous cyst. Pseudomyxoma peritonei.
106	Roberg.....	Op.	F.	..	Med. Jahrb. Wien., 1867, vol. xiii, s. 179, also Handbuch der Path. Anat., iii, s. 184	Gelatinous cyst. Described as colloid carcinoma.
107	Rokitansky (from Stengel)	Aut.	..	..	Virchow's Archiv, July, 1911.....	Small cyst.
110	Sissojeff.....	Op.	..	..	Occidental Med. Times, 1892, vi, p. 387.....	Gelatinous cyst.
111	Shoemaker.....	Aut.	M.	60	Munch. Med. Woch., 1899, 35, s. 1782.....	Small cyst.
112	Staubenrauch.....	Op.	M.	23	Munch. Med. Woch., 1899, 35, s. 1782.....	Small cyst.
113	Staubenrauch.....	Op.	..	19	Discussion of Vaughan's case.....	Mentions small cyst.
114	Stavey.....	Op.	..	..	Journ. A. M. A., 1906, 46, p. 495.....	Possible colloid carcinoma.
115	Stengel.....	Aut.	F.	50	Referred to by Van Hook.....	Small gelatinous cyst.
116	Steiner.....	Aut.	F.	30	Referred to by Van Hook.....	Small gelatinous cyst.
117	Steiner.....	Aut.	..	..	Referred to by Van Hook.....	Small gelatinous cyst.
118	Steiner.....	Aut.	..	..	Referred to by Van Hook.....	Small gelatinous cyst.
119	Steiner.....	Aut.	..	..	Referred to by Van Hook.....	Small gelatinous cyst.
120	Stimson.....	Aut.	F.	55	ANNALS OF SURGERY, 1896, p. 186.....	Small gelatinous cyst.
121	Stone, I. S.....	Op.	..	..	Discussion of Vaughan's case.....	Developmental irregularities.
122	Sonnenberg.....	Aut.	..	..	Path. u. Therap. du Perityph., Leipzig, 1905.....	Small cyst.
123	Tomita.....	Op.	..	..	Cent. f. Allg. Path. u. Path. Anat., 1907, s. 849.....	Small pseudomucinous cyst.
124	Treves.....	Op.	..	..	From Van Hook.....	Escape of contents into meso-appendix.
125	Treves.....	..	..	..	From Van Hook.....	Gelatinous cyst.
126	Treves and Swallow.....	..	..	..	Lancet, February 9, 1899.....	Gelatinous cyst.
127	Trotter.....	Op.	..	..	British Med. Jour., March 9, 1910, p. 681.....	Mucous cyst.
128	Vaughn.....	Op.	M.	36	Wash. Med. Annals, Wash., D. C., May, 1911.....	Pseudomyxoma peritonei.
129	Vaughn.....	Op.	..	..	Observation.....	Small cyst.
130	Van Hook.....	Op.	..	..	Medicine, March, 1896.....	Large cyst.
131	Vimont.....	Op.	..	..	Bull. de la Soc. Anat., Paris, 1887, vol. 62, p. 608	Cyst in hernial sac.
132	Virchow.....	Aut.	F.	..	Die Krankhaften Geschwülste, 1863, I, s. 250.....	"Mucocele."
			..	..		Cyst size of a fist. "Hydrops."

No.	Author	Source	Sex	Age	Reference	Condition
133	Wainhold.....	Op.	F.	74	Monatsschr. f. Geburtsh. u. Gyn., April, 1909...	Large pedunculated cyst. "Slightly turbid contents," probably fluid.
134	Werthe.....	..	..	..	Archiv f. Gynäk., 1884, 24, s. 100	Mucous cyst.
135	Wenzel-Gruber.....	Aut.	..	..	Virchow's Archiv, Bd. 63, H. L., s. 98	Cyst drained by incision.
136	Wier.....	Op.	M.	55	Med. Record, 1880, vol. 17, p. 44	Cyst drained by incision.
137	Wilks (from Stengel).....	Op.	..	..	Refers to similar case	Large mucous cyst.
138	Wilson.....	..	..	..	Quoted by Fagge. Tr. on Append., London, ii, p. 174	Small mucinous cyst.
139	Wilson.....	Op.	F.	68	Lancet, 1912, p. 1498	Ruptured cyst.
140	Wood.....	Op.	F.	52	Am. Jour. of Obstetrics, January, 1900, p. 15	Large hydropic cyst.
141	Wölfler.....	Op.	M.	19	Archiv f. Klin. Surg., 1879, xxi, s. 432	Cyst in hernial sac.
142	Zdeker.....	..	..	..	Prag. Med. Woch., 1888, xxvii, s. 340	An emptyema.



## MEGACOLON

HIRSCHSPRUNG'S DISEASE—REPORT OF A CASE IN AN ADULT

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HIRSCHSPRUNG'S disease, ordinarily a disease of infancy and childhood, is described in many of the text-books on surgery as a congenital, idiopathic dilatation of the colon. This is only true when the word "colon" is used in its larger sense as meaning the large bowel. Hirschsprung in his original two cases (*Jahrbuch von Kinderheilk.*, 1887, xxvii) described the dilatation of the sigmoid as more pronounced than that of the colon. Articles by Finney (*Surgery, Gynecology and Obstetrics*, 1908) and Wagner (*Surgery, Gynecology and Obstetrics*, 1906, vi, page 44) are also of cases where in addition to a dilatation of the colon the sigmoid as well was decidedly dilated and hypertrophied.

Neugebauer (*Erg. d. Chir. u. Orth.*, 1913, vol. xvii, 598) in a series of 169 cases found the sigmoid alone involved in 74. Barrington-Ward (*Brit. J. Surg.*, 1914, i, 345) reports 19 autopsies from the Hospital for Sick Children in London in whom all the sigmoids were dilated. Mention is made that even the rectum at times is involved.

The description, therefore, given by Brewer in his *Text-book on Surgery* (1915 edition) is perhaps as concise and satisfactory as any. It reads, "This rare condition, as the name implies, consists of a chronic dilatation of the sigmoid and even of the greater part of the transverse and descending portions of the colon, resulting in an enormous accumulation of fecal matter and gas." It is generally understood (Barrington-Ward) that cases where a definite obstruction is present do not belong under this classification. Occasionally, however, in the literature such a case is reported as one of Hirschsprung's disease. As the condition is of congenital origin, it naturally follows that clinically these cases are usually found in infants and young children. Occasionally some one with possibly a less marked condition grows up and the pathological condition is not recognized until adult life is reached. These adult cases are necessarily more rare. It is, therefore, justifiable to report even an isolated case of such a condition.

In a well-developed case the treatment is almost necessarily surgical. In the cases with less dilatation, it is conceivable that medical

treatment might help. Duval's mortality is 74 per cent. in the cases treated medically and 34 per cent. in those treated surgically in 59 cases; Lowenstein found a mortality of 66 per cent. treated medically and 48 per cent. treated surgically in 44 cases. Terry in 110 cases treated surgically finds a mortality of 25 per cent. (Barrington-Ward).

Neugebauer (*Erg. d. Chir. u. Orth.*, 1913, vol. xvii, 598) reports in 133 cases treated internally a permanent cure in but 1½ per cent.

An ideal treatment is, it seems to me, excision of the dilated portion of the intestine with an anastomosis between normal pieces of the intestine. This is a large operation. It is of interest, however, to know that Lane has done it on five children whose ages were three, six, nine, ten and a half, and twelve years, with the death of only one, not due to the operation but to a slipping of a ligature. Perthes (*Bert. z. klin. Chir.*, 1914, xc, 575) advises removing the dilated portion of the intestine by pulling it down through the anus, cutting it off and doing an anastomosis just beyond the anus. The bowel is then tucked back inside of the anus. This is, he says, applicable to that particular class of these cases where there is a congenital lengthening of the flexure and colon. This allows the colon to be pulled down through the rectum. He has devised a metal button for facilitating this.

Neugebauer believes strongly in resection and gives 56.5 per cent. cure following immediate resection and 90 per cent. cure from operation for resection done in stages. He says that diarrhoea following ileosigmoidostomy is to be but little feared.

*Report of Case.*—Miss H., twenty-four years old; born in Maine. While an infant, bowels did not move satisfactorily. From then to about ten years of age said to have been all right. At ten had an attack of "stoppage," vomiting, delirium, unconsciousness and fever, with the development of a tumor on the left side. Very sick. In bed a week. Relieved by glycerin enemata. After this attack, bowels were always constipated. Laxatives always necessary. At eleven years another attack, not so bad. Bowels became more and more constipated. Many attacks of stoppage; at least one a year, with vomiting, fever, delirium, pain on left side. The left-sided tumor at this time was always present, even between the acute attacks.

In April, 1908, the appendix was removed. Wound opened up after operation, and a second operation necessary to close it. Treated then for ulcer. Took enemata. Left leg then began to give trouble, difficult to move it. In the summer of 1909 sick



FIG. 1.—Megacolon.

1880  
1881  
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1886  
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1889  
1890

## MEGACOLON

with high temperature and all the symptoms of typhoid, even rose spots. Not considered typhoid, however, for after a few days of pain, fever and delirium the temperature would fall to subnormal, and patient would be all right for several days. The symptoms then would appear again and the temperature rise only to subside again.

It was in October, 1913, that for the first time I saw the patient with Dr. Drowne. At that time, to have a movement enemata had been necessary for two years. Recently the difficulty had increased so that the fluid of the enema was retained and massage was necessary each time to expel it. An X-ray picture (Fig. 1) by Dr. Percy Brown after a bismuth enema showed a dilated and convoluted sigmoid, and dilated descending, transverse, and ascending colons. The patient was incapacitated for work. Medical treatment had been thoroughly tried and had given no great benefit. She was poorly nourished, with poor vitality, and in such a condition that an extensive operation seemed out of the question.

Under nitrous oxide, oxygen, ether sequence, October 10, 1913, the ileum was divided just above the ileocaecal valve. Both ends were closed. The ileum was then fastened to the upper rectum or lower sigmoid by a lateral anastomosis. The sigmoid was then divided just above this anastomosis, the lower end closed and the upper end brought out into the wound. The abdominal incision was then closed, leaving the opening in the sigmoid on the surface. I made this artificial opening to drain the ascending, transverse and descending colons and to prevent any accumulation in faeces here through retroperistalsis at the site of ileosigmoidostomy. Patient stood the operation well, but for the first few days she was very uncomfortable and sick with frequent vomiting. The pulse, temperature, and examination of the abdomen were all negative and the rectal tube found gas and faeces, showing that the anastomosis was functioning.

After the patient had gone home an abscess developed just above the colostomy opening, which at times discharged gas and brownish material. At this time she was eating anything she chose without any distress. Had one to three normal movements a day without any laxatives or enemata.

On April 3, 1914, the abdomen was opened again, the sigmoid and colon back to the caecum were then removed—a little more than three feet in all. The upper end still contained putty-like masses which appeared to be faeces. A loop of the intestine was found adherent to the abdominal wall under the fecal fistula. This was dissected free from the wall and the opening in it sutured. Patient stood the operation remarkably well.



JOSHUA C. HUBBARD

After this operation the fecal fistula appeared again and since has caused a great deal of bother and required several operations. Now, however (October, 1915), it is closed so that only rarely is there any discharge of gas. The patient has improved steadily so that now she considers herself perfectly well and she looks the picture of health. She has gained in weight and during the last summer she was able to do the housework on a farm employing four men. Her bowels move easily with a small dose of Russian oil.

## SIGMOIDOVESICAL FISTULA\*

WITH REPORT OF A CASE

BY ROBERT C. BRYAN, M.D.

OF RICHMOND, VIRGINIA

VESICO-INTESTINAL fistulæ are comparatively rare—the sigmoidovesical variety ranking about third in order of frequency. According to Chavannaz they form 24.07 per cent. of all vesico-intestinal fistulæ. Of the 385 cases of enterovesical communications collected by Parham and Hume, in 278 of which the type of fistula is given, there were 33 cases of the sigmoidovesical variety. Our own study is based upon 42 cases which we were able to collect from the literature. The first authentic case is most probably the one reported by Frank in 1786.

Though the condition was known to the ancients, no valuable study of the subject appeared until Blanquinque wrote his thesis in 1870. Following this, Cripps, Chavannaz, Pascal and others contributed excellent studies also. A good review of the topic in the English language was published in 1909 by Parham and Hume. Chavannaz and Herczel report patients who were driven to suicide on account of this affliction, and Rotter states the case of a man who, not being able to obtain employment, on account of the odor about him of constantly decomposing urine and the involuntary expulsion of flatus per urethram, deliberately committed a crime so that he might get himself arrested and thus be assured of board and lodging.

The case which the writer wishes to report was referred March 1, 1915, by Dr. C. M. Scott, of Bluefield, W. Va.

W. C. B., aged forty-eight years, a carpenter; married, with 2 healthy children.

One sister died of tuberculosis, another sister had cancer, otherwise family history is negative.

Patient had typhoid fever at eighteen, contracted gonorrhœa at twenty-three, denies any history of syphilis, and had pneumonia at thirty-eight. The present trouble started about two years ago with pain in the left flank. At times the pain was very severe, particularly when somewhat constipated, so that he soon found out that following the use of a purgative he would feel better. Occasionally there would be 2 or 3 months between attacks, but

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\* Read before the Medical Society of Virginia, October, 1915.

recently the length has been shortened to two or three weeks, at times the pain becoming so severe that it required the attention of a physician. For years he has had a flat ribbon stool and has had to strain to have an action, requiring large cathartics.

In October, 1914, he noticed that gas and bubbles were present in the urine, which burned some. This has been more pronounced recently, and he now notices not only the bubbles but also hard, black particles. This is invariably the rule when at stool, but not so marked when standing up. Twelve years ago when in Washington he was seized with one of these attacks of pain and a physician was called in who told him he had a stone in the bladder which had cut through to the intestines. This is the patient's explanation of his present trouble.

At times he has been a hard drinker and is an incessant smoker.

Examination shows a rather anæmic man, 5 feet 9 inches in height, weight 150 pounds, the protruding belly and retracted thorax of evident visceroptosis. Skin is flabby and pale. Heart and lungs are normal. Liver not enlarged. No scars on the body; teeth good.

In the left flank a tumor is felt about the size of an egg, which is freely movable, particularly to the middle line, and which gives a little pain on handling. Cystoscopy is unsatisfactory on account of the large amount of mucus and debris which floats in the bladder, but a darkened area is noted in the vertex. The Wassermann reaction is positive ++++. Urinary examination shows no blood, considerable pus, no crystals, no casts, no tubercle bacilli; fæces and *Trichomonas intestinalis hominis* are found. Renal function test showed appearance in 9 minutes, and 20 per cent. for the first hour, and 12 per cent. for the second; total of 32 per cent. Blood count: red blood-cells 4,104,000; white cells 10,000. X-ray by bismuth rectal injection gives immense ballooning of the sigmoid proximal to the stricture, but no communication established with the bladder.

On March 6, under ether anaesthesia, a left low intermuscular operation was performed, sigmoid drawn to the median line and was found to be stuck to the summit of the bladder by a fistulous tract of about  $\frac{1}{2}$  inch in length. This was dissected loose, the bladder hole was burned with carbolic acid and alcohol and invaginated with purse-string and reinforced with catgut. A normal Meckel's diverticulum about 3 inches in length was noticed anterior and unattached to the fistula, with its free end pointing upward. This was not disturbed. The small intestines were dissected loose, the rough necrotic hole in the sigmoid was freed, and its edges, made diamond-shaped toward the mesenteric border, were brought together with catgut, reinforced with linen. Drain-



FIG. 1.—Note the Meckel's diverticulum anterior and internal to the fistulous tract, and unattached.



FIG. 2.—Tumor excised. Hole in the bladder and sigmoid inverted and reinforced with silk sutures.

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## SIGMOIDOVESICAL FISTULA

age instituted and catheter inserted for 3 days. The patient did well for 5 days, developed suppression of urine, and died March 11, 1915.

*Sex.*—Of the two sexes, man is much more frequently affected than woman, the ratio being, according to Pascal, about 3 to 1. Of our 42 cases 27 were males, 14 females and 1 sex not given.

*Age.*—The age factor was represented in our own cases as follows:

Age not given .....	6
Between 20 and 30 years .....	3
Between 31 and 40 years .....	7
Between 41 and 50 years .....	5
Between 51 and 60 years .....	14
Between 61 and 70 years .....	4
Between 71 and 80 years .....	2
Between 81 and 90 years .....	1

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*Etiology.*—The rarity of accidental traumatic sigmoidovesical fistulæ may well be surmised when one remembers how rare traumatic injuries to the pelvic organs are.

Pascal's classification has largely been adhered to in the literature. It serves the purpose well but should include under the non-traumatic inflammatory variety diverticulitis and amœbiasis, as cases of this etiologic nature have been reported. Thus:

(1) Traumatic: (a) Accidental; (b) surgical.

(2) Non-traumatic: (a) Inflammatory, including abscess, stricture, stone, ulcer, diverticulum; (b) malignant; (c) tuberculous; (d) syphilitic; (e) actinomycotic; (f) amœbic.

In connection with this etiologic classification one may speak of vesico-intestinal fistula originating in the bladder, in the intestines, or in the neighboring organs. As is well known the most common seat of diverticulitis is in the neighborhood of the sigmoid flexure. Heine deserves the credit for calling especial attention to this phase of the subject.

*Pathology.*—An illustration from recent literature of the difficulties of positive diagnosis is that reported by Parham in 1909. His case was believed to be by the author an inoperable malignant condition, and a palliative colostomy was performed. Thirteen years later the patient was reported as doing well, a circumstance which led the author to hint that the case might have been one of sigmoid-diverticulitis. We are inclined to believe with Chute that the latter diagnosis was in all probability the correct one. Whatever convictions concerning the

etiology of this condition one may have gained from reading the literature on vesico-intestinal fistulæ in general, it appears well substantiated that diverticulitis is the most frequent cause of sigmoidovesical fistulæ. From the reported cases our etiological table resolves itself into the following:

	Cases
Sigmoid diverticulitis .....	15
Probable sigmoid diverticulitis .....	6
Inflammation (?) .....	4
Surgical traumatism .....	3
Carcinoma of sigmoid .....	3
Carcinoma of bladder .....	2
Carcinoma not specified .....	2
Ovarian abscess .....	2
Amœbic sigmoiditis .....	1
Carcinoma or gumma of sigmoid .....	1
Tuberculosis .....	1
Stricture .....	1
Ulceration .....	1

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Apparently 22 out of the 42 cases were due to a diverticulitis of the sigmoid with subsequent adhesion to bladder and fistulous formation.

*The Etiology of Diverticula and Fistulous Diathesis.*—As has been stated, Heine was one of the first to devote a special study to the subject in his thesis of 1904. An excellent and very exhaustive study in the English language was published by Maxwell Telling in 1908. The etiology of diverticula of the lower bowel is still obscure. It occurs usually in advanced age, is more common in males than in females, and obese persons seem to be more predisposed. The structure of the sigmoid and its physiological function, namely, the more or less prolonged retention in this part of the gut of accumulated fæces which exert pressure upon the lumen, have been advanced as causes. Louis B. Wilson sums up his study as follows: "It may be stated briefly that diverticula of the lower bowel, while frequently following the course of vessels, probably owe their origin more to congenital weakness of the circumferential musculature than to any other factor.

According to Mayo-Griffin the clinical diagnosis of diverticulitis cannot be made positively. Left-sided pain low in the abdomen (a circumscribed peritonitis), coming in spells and associated with constipation, brings it to mind. In view of the apparent frequency of the affection, this etiologic factor should always be borne in mind in all sigmoidovesical fistulæ. Failure to recognize the condition has led on

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more than one occasion to the abandonment of operation when radical work might have cured the patient.

To quote Telling, "diverticula themselves are buried in a mass of hardened fibrous tissue which very frequently produce secondary adhesions to adjacent viscera. This leads to the mimicry of carcinoma. Many times the tumor has been dealt with under this mistaken diagnosis, such specimens being found in museums labeled 'carcinoma.'"

From the anatomical relationship of the parts, it is obvious that an adhesion between a peridiverticulitis and the bladder will be likely to occur. When it is remembered that such adhesions occur at the end of a pouch which has fecal contents, and which pouch may at any time become perforated and give rise to a suppurative process between the inflammatory sigmoid mass and the bladder wall, it is simply following the course of an appendix which ruptures into a hollow viscus. The fistulous communication is often a narrow and tortuous tract which tunnels a considerable thickness of inflammatory fibrous tissue or more rarely has an immediate anastomosis. Chute discusses at length the mechanism of diverticula formation. He thinks the actual cause of these diverticula is probably an increased pressure in the bowel due to constipation or an increased formation of intestinal gas. He believes that the most probable predisposing factor is the one suggested by Bland-Sutton, namely, that there is often a fatty infiltration of the bowel wall just under the epiploic appendages that weakens it at this point. "Once a pouch has formed, it becomes filled with stagnant bowel contents. Since there is practically no muscle fibre in the wall of the diverticulum, and as its entrance into the bowel is smaller than its distal end, we have present all the necessary factors for a diverticulitis." It is interesting to note in the writer's case the Merkel's diverticulum lying anterior to the union and unattached.

Mayo sums up his clinical observations of acquired diverticulitis of the large intestines as follows: "All the patients coming under observation have had certain features in common. They were over forty-five years of age; all but four were males and, excepting for this illness, were otherwise in robust health, most of them inclining to obesity. The onset of the symptoms was sudden, and presented the characteristics of a localized peritonitis. A tumor rapidly developed, and usually lay to the left of the median line, in the middle or lower quadrant of the abdomen." Concerning the part of the bowel affected Heine's study is of interest. In eight cases collected by him of vesico-intestinal fistulæ due to diverticulitis, the diverticulum was located in the sigmoid flexure in seven instances and once in the rectum.

*Symptoms and Diagnosis.*—The diagnosis of vesico-intestinal fistulæ should not be difficult. Vastly more important is the decision as to what part of the intestinal tract is involved in the fistula. The cardinal symptoms of all vesico-intestinal fistulæ are: (1) passage of gas by urethra; (2) passage of feces by urethra; and (3) passage of urine by rectum. Chute states that if the bowel contents found in the urine is dark and contains solid particles, it may be assumed that the connection is probably with the small intestines. On the other hand, Dittel does not think that we can obtain as much aid from the chemicomicroscopic examination of the urine as from a more delicate balancing of all the clinical manifestations and the history of the case.

Long standing complaints referable to the gastro-intestinal tract, such as chronic constipation, areas of local tenderness, transitory attacks suggestive of local peritonitic processes, will point to the intestines as the probable origin of the fistula. Conversely, long standing bladder affections, especially conditions involving ulceration of bladder wall, indicate that this organ gave rise to the fistulous communication. Localized pain in left lower abdomen and signs such as have been mentioned in connection with diverticula will point to a sigmoid diverticulitis as the etiologic factor. The specific state and Wassermann and luetin tests should be valuable diagnostic aids. X-ray, bismuth injections, cystoscopy and proctoscopy should be carried out in all suspected cases.

The symptomatology of this affection is uniform in the cases reported. The majority showing as the most constant and annoying single symptom a pneumaturia, which is not only accompanied by an odor, but on escaping may be heard some distance from the patient. According to Parham and Hume pneumaturia may occur after (1) instrumental vesical manipulation, litholapaxy, etc.; (2) in certain neuropathic conditions; and (3) in glycosuric conditions, the decomposing urine containing sugar. The exclusion of any of these conditions should, however, not be difficult in the presence of other symptoms, such as passage of fecal matter per urethram and urine by rectum. The last named symptom is only present, according to Chavannaz, in one-third of the cases, a circumstance which is readily appreciated when it concerns communication with some part of the bowel higher up. Next in importance are the painful tenesmus and symptoms of cystitis. The development of this is insidious, and these indefinite symptoms continue until the patient suddenly finds himself passing gas per urethram, or more rarely notices urine expelled by the rectum.

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*Prognosis.*—Aside from the local symptoms the general condition of the patient suffers a great deal in most cases. Mental anxiety, insomnia, loss of weight and exhaustion are common phenomena, which invalidate the unfortunate for work. In rare instances no general disturbances of health occur and the patients live for many years apparently not much the worse for the affection. The average duration of life, however, according to Pascal's statistics is three years.

Of our 42 cases of sigmoidovesical fistula, 30 died, 9 recovered, 2 improved and in 1 the result is not given. The prognosis is therefore grave. Only 1 case recovered spontaneously. Of Pascal's 300 cases of enterovesical hiati, 19 recovered spontaneously, 15 recovered under expectant treatment, and 24 were cured by operative measures. The prognosis is best in the traumatic variety. Of the 3 cases in our series, 2 recovered following operative interference. Next comes the inflammatory variety. The tuberculous and carcinomatous varieties are the least favorable.

*Complications.*—Aside from the immediate symptoms certain serious complications may ensue from a fistulous communication between the bladder and intestines. Among these must be mentioned ascending renal infection, which occurred 18 times out of 250 cases of Pascal's table. Fourteen times the infection was bilateral. The relative rarity of this complication is explained by Chavannaz on the theory that the bladder in its battle with infection usually maintains the upper hand, and Heubner states that the colon bacillus is less harmful when it enters the bladder direct than when it gains access per urethram.

A rarer complication is calculus formation in the bladder as a result of the passage of fecal matter into this organ. The effect of the passage of urine into the bowel depends largely upon the state of the urine. Undecomposed urine has no deleterious effect upon the intestinal mucosa and considerable amounts may be absorbed. Decomposed urine, on the other hand, causes an inflammatory condition with resultant diarrhoea and painful tenesmus.

*Treatment.*—Vesico-intestinal fistula is essentially surgical. The older writers have reported cures from purely medical treatment. These were doubtless specific cases in which mercury and iodides were used. But this was when a laparotomy was a vastly more serious proposition than it is to-day. Whatever the statistics may show with reference to the value of medicinal treatment alone in vesico-intestinal fistula, the 9 recoveries and 2 improvements recorded in our 42 cases of sigmoidovesical fistulae were due in every instance except one to surgical interference. The 1 case recovered spontaneously. There are cases in



which operative procedure is contra-indicated, either because of the general condition of the patient or because of the nature of the etiologic factor. In these instances medicinal treatment may be of benefit.

The surgical treatment resolves itself into (1) palliative and (2) curative. Under palliative treatment Parham and Hume suggest the removal of stone by lithotomy or lithotrity, the dilating of strictures, colotomy and colostomy, suprapubic cystotomy, intestino-anastomosis and lumbar transplantation of the ureters or by perineal or vaginal attack when the communication is low. These authors caution that when colostomy is decided upon it is necessary that it should be done so as to fulfil two conditions. First, it must be above the fistula, second, it must be complete, so as to have no connection between the upper and lower segment of the intestine. Colostomy was very much more in vogue formerly than it is now, and it appears that its most useful place in the treatment of this condition is as a preliminary procedure to a radical closure of the fistula introperitoneally. Used in this way it may improve the chances of success for a subsequent radical operation. In our 11 cases of recovery and improvement, colostomy was responsible for only one recovery and the two improved cases. The radical operative procedure is best accomplished by the inter-abdominal separation of the sigmoid and bladder and suture of the openings. Concerning the failure of this method in his two cases Chute says, "Beside the technical difficulty of doing a plastic operation in the depths of the pelvis, there are two other things that militate against success in closing these diverticular openings in the sigmoid. The first is the frequency with which there is a narrowing of the sigmoid below the opening of the diverticulum, which increases the pressure on the suture line, and if this narrowing is marked, makes success practically impossible. Such a narrowing may be due either to an infiltration of the bowel wall with secondary contraction of the lumen, or to the pressure of a mass of inflammatory exudate against the bowel from the outside. The other factor that renders success difficult in these cases is the poor condition of the bowel for suture. It is thickened, making folding in of the wall practically impossible; it is friable, making it difficult to have sutures hold; and finally, its nourishment is interfered with to a degree that makes union slow and uncertain."

Thorough resection of the diseased segment of sigmoid, end-to-end anastomosis and free drainage should remove this obstacle. Westhoff excised the sigmoid in a female forty-three years of age with recovery. Short circuit lateral anastomosis as was done successfully by Sauther may also be considered.

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Cunningham, in a recent article reviewing the literature of rectovesical and enterovesical fistulæ, reports 342 cases and states that the most common location of the opening is in the rectum, nearly 50 per cent. of all cases being formed here, and that the next most common location is in the sigmoid. Cunningham prefers the operation by abdominal section, which, as he says, gives not only the best approach, but is suitable also to the traumatic and inflammatory types and is the method of choice in the malignant or tuberculous states.

### BIBLIOGRAPHY

- <sup>1</sup> Heine, Walter: Über Darmblasenfisteln infolge von Darmdivertikel. Inaugural Dissertation, Leipzig, 1904.
- <sup>2</sup> Chavannaz: Des fistules vesico-intestinales acquises chez l'homme. *Annals des maladies des organes genito-urinaires*, 1897.
- <sup>3</sup> Herczel, E.: Beiträge zur oper. Behandlung der Blasen-Mastdarmfistel. *Beitrage zur klin. chir.*, Bd. v, Hft. 3.
- <sup>4</sup> Rotter, J.: Die operative Behandlung der Blasendarmfistel beim Manne. *Arch. f. klin. chir.*, Bd. 31.
- <sup>5</sup> Blanquique: Etude sur les fistules vesico-intestinales. Thèse de Paris, 1970.
- <sup>6</sup> Cripps, H.: The Passage of Air and Fæces from the Urethra. J. & A. Churchill, London, 1888.
- <sup>7</sup> Pascal: Thèse de Paris, 1900.
- <sup>8</sup> Parham and Hume: Vesico-intestinal Fistulæ. *ANNALS OF SURGERY*, vol. v.
- <sup>9</sup> Frank: Cited by Pascal.
- <sup>10</sup> Chute, A. L.: *Trans. Am. Ass. Genito-Urin. Surgeons*, N. Y., 1911, vi, 86-98.
- <sup>11</sup> Telling, Maxwell: *The Lancet*, vol. i, 1908.
- <sup>12</sup> Wilson, L. B.: *ANNALS OF SURGERY*, vol. liii, 1911.
- <sup>13</sup> Mayo-Griffin: *Surgery, Gynæcology and Obstetrics*, vol. v, 1907.
- <sup>14</sup> Telling, Maxwell: *The Proctologist*, vol. v, No. 1.
- <sup>15</sup> Dittel: Dinndarmblasenfisteln, *Wiener med. Wochenschrift*, No. 10-12, 1881.
- <sup>16</sup> Heubner: *Berliner Klin. Wochenschr.*, November 30, 1899.
- <sup>17</sup> Cunningham, J. H.: Retrovesical and Enterovesical Fistulæ. *Surg., Gynæc. and Obstet.*, vol. xxi, No. 4.

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No.	Year	Author	Sex	Age	Cause	Treatment	Result	Duration
1	1786	Frank	Male	73	Sigmoid diverticulitis	Not given	Autopsy	Several months.
2	1820	Rabouam	Female	24	Inflammation	Not given	Autopsy	One month.
3	1826	Boyer	Male	60	Sigmoid diverticulitis	Laparotomy	Death	Several months.
4	1831-32	Salmon	Female	59	Sigmoid diverticulitis	Palliative medicinal	Autopsy	Five months.
5	1836	Mercier	Male	76	Inflammation	Not given	Death	Not given.
6	1842	Taignot	Male	65	Cancer	Not given	Death	Not given.
7	1853	Simpson	Female	..	Abscess ovary	Not given	Death	Not given.
8	1856	Malcolm	.....	..	Tuberculosis	Not given	Autopsy	Not given.
9	1858	Sidney Jones	Male	64	Sigmoid diverticulitis	Not given	Autopsy	Ten months.
10	1859	Hulke	Male	57	Chronic sigmoiditis around numerous diverticula	Not given	Autopsy	Two and a half years.
11	1861	Tangel	Male	56	Sigmoid diverticulitis	Colostomy	Autopsy	(?)
12	1866	Holmes	Male	51	Sigmoid diverticulitis	Colostomy	Autopsy	Not given.
13	1869	Mauder	Male	59	Ulceration	Colostomy	Death	Not given.
14	1871	Healop and Simpson	Female	..	Ovarian abscess	Not given	Autopsy	Over a year.
15	1874	Morison	Male	50	Sigmoid diverticulitis	Palliative	Autopsy	Four years.
16	1877	Bruchet	Male	67	Stricture	Not given	Autopsy	Not given.
17	1889	Hermanides	Female	36	Inflammation	Not given	Spontaneous cure	Five months.
18	1889	Herczel	Male	48	Sigmoid diverticulitis	Laparotomy and colostomy	Autopsy	Six months.
19	1890	Battistini	Male	..	Not given	Colostomy; irrigation	Great improvement	
20	1894	Heuston	Male	35	Carcinoma of intestines	Laparotomy	Death	Four days.
21	1894	Peron	Male	36	Carcinoma of sigmoid	Laparotomy	Autopsy	Not given.
22	1897	Schwartz	Female	28	Inflammation	Laparotomy	Improvement, then death	
23	1897	Genoville	Male	61	Sigmoid diverticulitis	None	Autopsy	Two years.
24	1898	Kelly and Callum	Female	60	Sigmoid diverticulitis	Laparotomy	Recovery	Two years.
25	1898	Taffier and Dumont	Female	52	Carcinoma of sigmoid	Laparotomy	Autopsy	Not given.
26	1900	Savariaud quoted by Pascal	Female	40	Abdominal operation, surgical injury	Resection and enteroneous union; laparotomy; resection	Autopsy	Not given.
27	1902	Hepner	Female	64	Sigmoid diverticulitis	Laparotomy	Recovery	Fourteen months.
28	1902	Cherry quoted by Waldvogel	Male	..	Sigmoid diverticulitis	Colostomy	Autopsy	Not known.
29	1902	Waldvogel	Male	35	Sigmoid diverticulitis	Palliative	Autopsy	Fifteen years.
30	1904	Heine	Female	59	Perisigmoiditis around numerous diverticula	Laparotomy	Recovery	One year.
31	1906	Royster	Female	22	Surgical traumatism	Laparotomy	Recovery	One year, plus.
32	1907	Mayo and Griffin	Male	..	Probably diverticulitis	Not known	(?)	(?)

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	1907		Sex	Diagnosis	Operation	Result	(?)
33	1907	Mayo and Griffin	Male	Probably diverticulitis	Laparotomy	Good result; persistent fecal fistula	
34	1907	Wenthoff	Female	Surgical traumatism	Excision of sigmoid	Recovery	Ten years.
35	1908	Pennington	Male	Carcinoma of rectum sigmoid	Colostomy and suprapubic cystostomy	Autopsy	Six weeks.
36	1909	Parham and Hume	Male	Sigmoid diverticulitis	Colostomy	Improved	Thirteen years.
37	1911	Sauther	Male	Carcinoma of gumma of sigmoid	Short circuit; later anastomosis	Recovery	(?)
38	1911	Chute	Male	Sigmoid diverticulitis	Laparotomy	Death	Five or six years.
39	1911	Chute	Male	Sigmoid diverticulitis	Laparotomy	Autopsy	Fifth day after operation.
40	1912	Boehm and Dean	Male	Carcinoma of bladder	Not stated	Autopsy	Seven months.
41	1912	Boehm and Dean	Female	Carcinoma of bladder	Excision of sigmoid	Autopsy	Two years.
42	1912	Levison	Male	Amoebic sigmoiditis	Colostomy	Recovery	Several weeks.
43	1914	Bryan	Male	Syphilitic	Excision	Death	Two years.

## A STITCH TO ASSIST IN THE CLOSURE OF THE POSTERIOR SHEATH OF THE RECTUS ABOVE DOUGLAS'S SEMILUNAR FOLD

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It must frequently have been the lot in the experience of every surgeon to find that the distention of the intestines greatly hampered the drawing together of the peritoneum and fascia in the upper abdomen. This is especially true in paramedian incisions. Failure to properly draw these structures together has resulted in imperfect union of these important layers and in unsatisfactory repair of the abdominal wall in this region. It will be remembered that the upper two-thirds of the abdomen is harder to close than the lower third on account of the intimate association of the peritoneum with the fascial structures, the fibres of which run in a general way across the body. Frequently an ordinary running stitch will show a tendency either to pull out or to slit the fascia in the direction of its fibres at each stitch hole. A mattress stitch holds no better.

It was in an effort to overcome this tendency of the suture to split the fascial fibres that I fell upon the stitch here described. I make no claim at originality in it, but I have never read of its being used, and a number of men to whom I have shown it during the past year and a half have never seen it before.

It may be either an interrupted (Fig. 1) or a continuous stitch (Fig. 2). The principle upon which it operates is that of a tendon suture which grasps a fasciculus of the tendon with a loop, and the tighter it is drawn the tighter it holds this fasciculus. A glance at these illustrations will show the method of its operation. The application of it is as follows: The needle is put through the posterior layer of the internal oblique and the transversalis aponeurosis, transversalis fascia and peritoneum with one stroke; then brought out with another stroke, including some fasciculi of this combined aponeurosis; then it is returned again through the first hole and brought out again through the second hole, so that we have a complete loop surrounding these fasciculi; it is then brought across to the other lip of the wound and put through in a similar manner, placing the first puncture opposite to



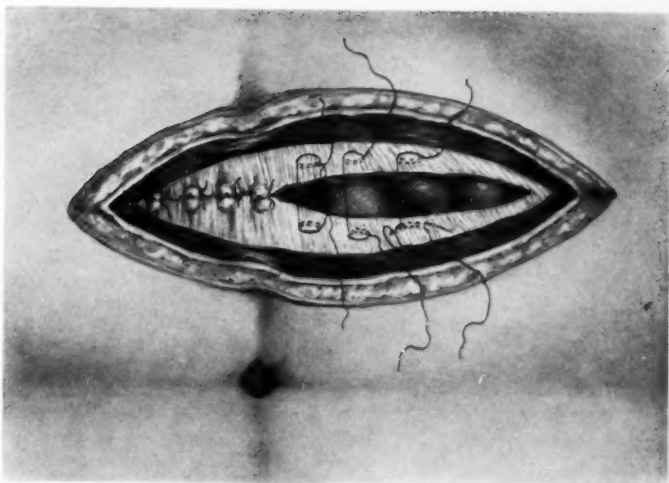


FIG. 1.—Interrupted stitch.

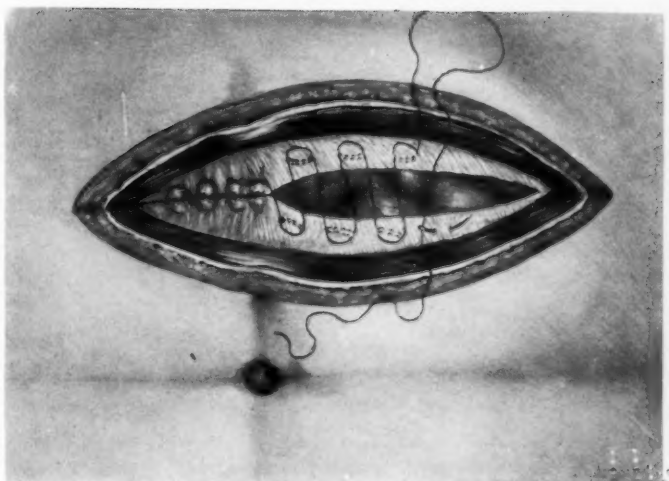


FIG. 2.—Continuous stitch. It shows the lower part of the wound drawn up tightly, and the upper few stitches placed loosely, ready to be "laced" up.

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### CLOSURE OF POSTERIOR SHEATH OF RECTUS

the last puncture of the other side. The ends are then tied with the ordinary first half of a square knot, and as these are pulled up the slack between the two loops is drawn up easily. The tighter it is tied the tighter will the loops around the bundle of fascia and peritoneum hold. The second half of the square knot completes the interrupted stitch. Plain catgut, chromic-gut or kangaroo tendon should be used, as it slips through the tissues readily when the stitches are drawn up. For the continuous stitch, the same procedure is done without tying between the stitches, and at the completion of each half of the stitch the slack is pulled up.

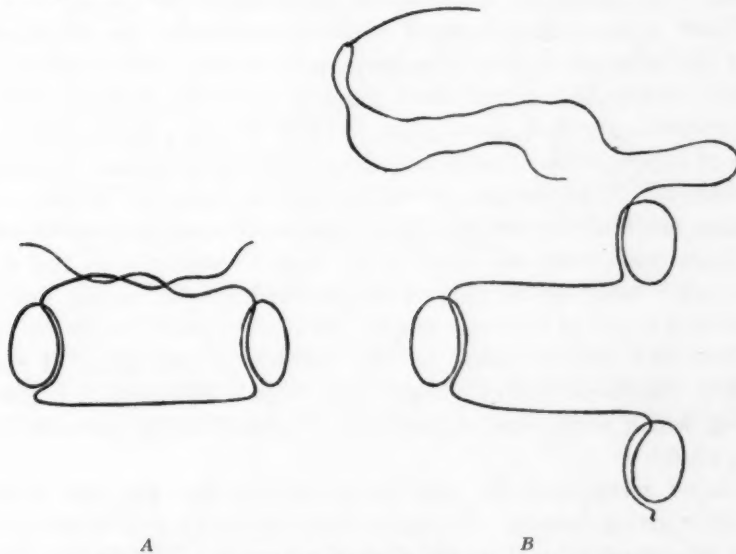


FIG. 3.—A, interrupted stitch; B, diagram of continuous stitch.

I am indebted to Dr. H. H. M. Lyle for a suggestion which I think is valuable. It is to begin the stitch from the peritoneal side and finish it on that side, so that the peritoneum is everted rather than inverted at its completion. This modification is applicable when there is but little tension, but in the presence of great tension I think the original way, *i. e.*, inverting the peritoneum and approximating the fascia, as is shown in the illustration, is the more feasible. I have used it in a number of cases and find that it works in a satisfactory manner.

## ARTIFICIAL IMPACTION OF HIP FRACTURE \*

BY FREDERIC J. COTTON, M.D.

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VISITING SURGEON TO THE BOSTON CITY HOSPITAL

OUR ordinary treatment of hip fractures has been dominated by two dicta: First, "You must treat the patient, not the fracture"; second, "You must not break up the impaction."

There is some truth in each of these statements, but in practical effect the influence of both pronouncements is bad. It is another case of the "dead hand" of traditional practice hampering present action.

Everyone who has taken pains to study his own hip fractures, or those of others, knows that lamentable results are common. Need they be common? Need the man or woman between forty and seventy, with a broken hip, look forward to a heavy chance of permanent uselessness? All things considered, one could hardly expect restoration of full activity in older patients, but loss of all practical weight-bearing function (often as a result of total non-union) seems too "poor" to put up with.

There is a vast literature on hip fractures; nearly all of it rather footless. Between Astley Cooper and Royal Whitman, I know of nothing worth while, save a paper by Newton Shaffer on work done about 1886.<sup>1</sup>

Cooper recognized the important classification but did nothing toward securing results. Whitman has something real, contributing to the attainment of real results along the lines Shaffer first laid down, but he would be in a stronger position if he had differentiated his cases into the two great groups.

The same is true of Maxwell, Phillips and Ruth—each of them has in turn demonstrated certain excellent results of the traction method each has employed; results inconclusive because not classified between the two great groups.

The fact is that hip fractures in adults are divisible into two classes:

1. Fractures at the base of the neck ("extracapsular fractures"), which are going to unite anyhow, with good or bad treatment; which may show great deformity and consequent disability, but practically never fail to unite.

2. Neck fractures proper (intracapsular fractures) in which the

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\* Read before the American Surgical Association, June, 1915.

<sup>1</sup> N. Y. Med. Journal, October 23, 1897, vol. lxii, p. 557.

## ARTIFICIAL IMPACTION OF HIP FRACTURE

proximal fragment (the head) may be mobile, and is always ill-nourished and ill-fitted for any share in the necessary repair.

These neck fractures proper may be impacted, or merely entangled, or loose. The loose fractures *never* unite under routine treatment, so far as I can learn. The loosely impacted fractures are rather apt to loosen up and to show results like those of fractures originally loose. The well-impacted fractures unite by bone, often with tolerable function, though the eversion unusually present is a serious factor in disability.

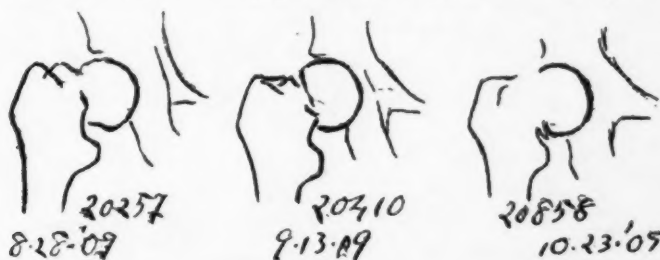


FIG. 1.—The first case: before impaction; after impaction; the final result. The result was rather good, but bony union uncertain.

Sometimes in these cases the shortening and coxa vara also are sufficient to entail further disability.

In the past the successful cases have been those of extracapsular fractures<sup>2</sup> which always unite, or those firmly impacted in fair position.

Years ago there came to me the idea of aiding nature by producing



FIG. 2.—First plate: sent out as impacted; sent back as re-fractured. See second plate. At this time patient was seen and presently was re-impacted under ether. Third plate shows results of re-impaction about two months later. Clinical result excellent.

impaction in loose fractures; carrying out by remodelling and re-impaction in cases primarily impacted, but impacted in such poor shape, anatomically, that reduction and re-impaction are greatly to be desired.

The idea of artificial impaction is a new one, I think, never carried

<sup>2</sup> For example, in Ruth's remarkable collection of 7 post-mortem specimens, to be noted later.



out previous to the cases I reported in the *American Journal of Orthopaedic Surgery*, in May, 1911.

Briefly, it comes to this. Unimpacted fractures of the femoral neck proper never unite by bone; well-impacted fractures do so unite, almost always. Obviously the conversion of cases of the first into



FIG. 3.—Loose fracture with much displacement shown in an X-ray now lost; ether reduction; re-impaction. The plate shows the position after operation. The re-impaction held and all went well until six weeks later, when the patient "went bad" and presently died, apparently of myocardial degeneration and consequent heart failure.

FIG. 4.—Woman, aged seventy-nine years; loose fracture. Seven years ago fracture of the other hip. Loose fibrous union with tolerable usefulness resulted. The second lesion is here shown; before and after treatment. Bony union was secured, but owing to her advanced age, to the defective function of the other hip and to some stiffness, she walks poorly but can walk.

cases of the second class is extremely desirable. Can it be done? I assert that it *can* be done; that it can be done without damage and without great difficulty, and can be done at any time within a fortnight at least, whether we are dealing with a fracture thoroughly loose when we first see it, with one which has loosened up in the first fortnight,

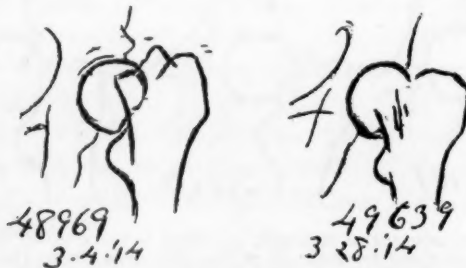


FIG. 5.—Before and after treatment. This was a loose fracture. The re-impaction held up to the last note. I have not traced this case to an end-result.

or with one in which we have deliberately sacrificed the original impaction to secure improved position.

The breaking up of hip fractures is far from new. I saw it done when I was a house officer, but the attempt to establish or re-establish a condition of impaction I believe to be entirely new and its possibility rests, to date, entirely on the data I have here. There are 21 cases

## ARTIFICIAL IMPACTION OF HIP FRACTURE

with 1 failure and 1 prospective failure. The first case was impacted no August 31, 1909.

Of these cases treated by the same technic, 4 proved to be extra-capsular fractures. In fractures of this type, the impaction procedure can give at best merely an easier fixation, and is probably no better

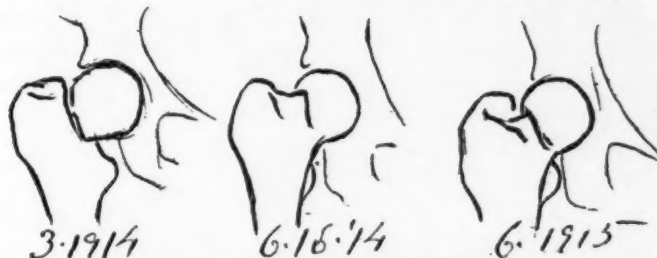


FIG. 6.—The first plate shows the fracture, unimpacted or at best loosely impacted; there was crepitus. The second plate shows the result shortly after reduction and mallet impaction. The third picture shows the end-result, after a year; slight shortening of the neck, but firm bony union. She has practically perfect motion and walks without a limp, unless much fatigued.

method than Whitman's simple abduction in these cases; probably not as good a method as the Phillips-Maxwell-Ruth method of longitudinal and lateral traction. Ruth has, or had recently, 7 post-mortem specimens showing admirable results by this method. All, or at least all save one debatable specimen,<sup>3</sup> were definitely extracapsular. I think this method probably the best for this type of cases; it seems illogical and is certainly unproved as to fractures of the femoral neck proper.



FIG. 7.—A loose fracture in a man of forty years. The first plate before and the second after impaction. He has returned to active work with excellent function. Not traced as yet, as to details of the end-result.

I do not wish to be taken as advocating forcible impaction in all cases, even of neck fracture proper. Not a few of such cases are simply cracks. Many show a sufficient accidental impaction, with deformity in adduction and eversion not great enough to warrant any interference. Some, of course, that show deformity enough to render correction desirable, are poor surgical risks.

<sup>3</sup> Obscured by osteo-arthritic changes.

FREDERIC J. COTTON

Here and there even loose fractures must be neglected because of the risks imposed by age, by heart lesions, by chronic pulmonary damage (usually bronchitic), by diabetes, etc., though the proportion of such non-surgical cases is apt to be over-estimated.

What I do maintain is that in all cases of loose fracture, in all cases in which impaction gives way, in all cases in which adduction and eversion deformity promise definitely poor results, the procedure herewith given is indicated, and should be carried out unless there are definite contra-indications.



FIG. 8.—Before and after reduction and impaction. Left the hospital with a solid hip. End-result to be traced.

The technic I have followed is this:

First anæsthetize the patient—not deeply—and put him on the table; preferably a Hoffa table, though even an ordinary wooden table will do. After measuring the length, drag the leg down (with your stockinged foot in the perineum) till the length comes out even, and until rotation gives definite slight crepitus; then correct any eversion deform-



FIG. 9.—Before reduction; a loose hip fracture; second plate, after reduction; third, before discharge. What happened in this case I do not know. I operated on a case referred in consultation and have no data as to after-care, save the plates. This I call one of the failures!

ity present; give the leg to an assistant; have another assistant give counterpressure on the opposite side of the pelvis; pad the trochanter with two thicknesses of saddler's felt and pound on it with a very large wooden mallet, till there is a sensation of "giving." The blow should be a slow swinging "following" blow, and the "giving" is very definitely felt in most cases. Then one should test the fact of impaction by the loss of mobility in rotation when the leg is released.

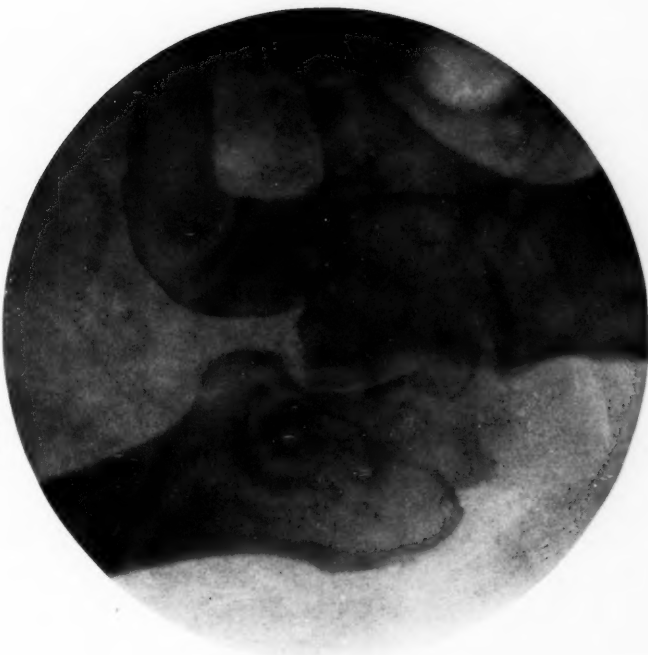


Fig. 12.—Before operation.



Fig. 13.—After impaction. In abduction plaster. Clinical result excellent.  
Bony union.

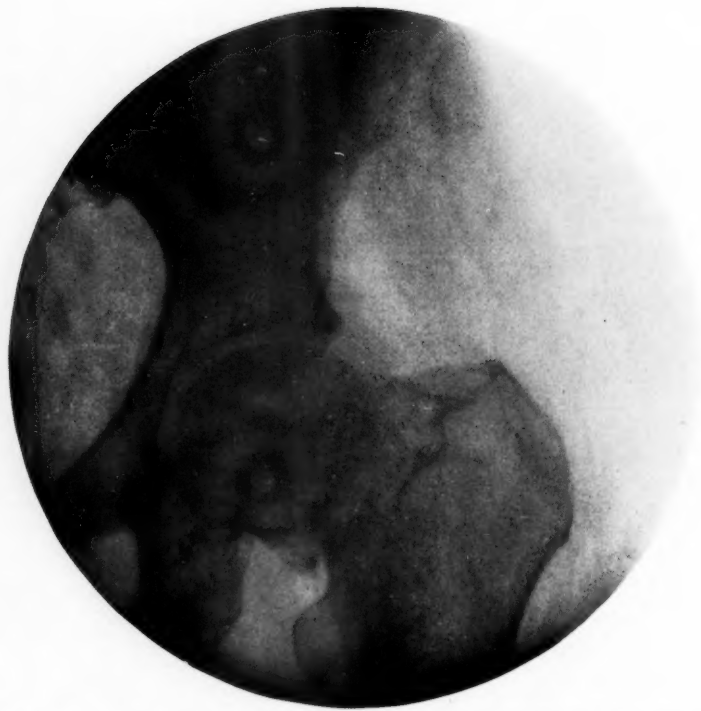


FIG. 14.—Four months after forcible reduction for extreme eversion and shortening and the usual mallet impaction and spica plaster. Bony union, and the patient now (six months) walks without pain and almost without a limp.



## ARTIFICIAL IMPACTION OF HIP FRACTURE

When the job is properly done, this loss of mobility is perfectly definite and rather striking. After impaction, the length of the two legs should come out very nearly even.

After all this is done, I put the leg up in an abduction spica of plaster. Abduction prevents adductor contracture, often troublesome in the period of re-establishment of function. It neutralizes the tendency



FIG. 10.—An old case of tabes. Hip shown before and after treatment. The fracture was unimpacted in the beginning. The artificial impaction held and bony union was secured; but the clinical result is that conditioned by the original tabetic condition.

to coxa vara from muscle-pull, and is a more convenient position in respect to the bed-care of the patient. In general, abduction is the optimum position for handling nearly all hip lesions of whatever sort, and I always use it when I can.

This first plaster I leave on six to eight weeks or longer. Not until three months do I dare let the foot to the floor. Repair in these



FIG. 11.—Operated for Dr. J. B. Blake; loose fracture; second figure shows after impaction; third figure shows impaction preserved, though with some absorption; early result excellent; too soon for end-result.

cases is slow at best. Always in hip fracture at the neck, there is a considerable absorption. Even with the X-ray, we cannot always judge and it is best to be cautious. From three to six months one is busy with getting the joint mobilized and learning to walk with crutches, bearing little weight on the hurt leg. During this time, nearly all the motion should be regained. After six months the question is one of use, of regaining strength and losing the limp.

TRANSACTIONS  
OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, held December 6, 1915*

The President, DR. JOHN H. GIBBON, in the Chair

OSTEOCHONDRITIS DEFORMANS JUVENILIS, OR PERTHES'S  
DISEASE

DR. JAMES K. YOUNG presented two cases of this disease, one of these, aged five years, was suffering from Perthes's disease of one hip, and the second one, aged five years, was suffering from Perthes's disease of both hip-joints.

The first boy came under observation, July, 1913, at the Polyclinic Hospital, complaining of lameness in the left hip. There is no history of injury and his mother knew of no cause for this condition. There is no history of tuberculosis in the family. The X-ray showed a typical atrophy of the epiphysis of the femur, with some roughening of the cavity of the acetabulum. There was no limitation of motion except in abduction; and the disease, after remaining stationary for a time, has gradually recovered, there being an increased deposit of lime salts. He wore an apparatus to relieve weight bearing, and he was given calcium phosphate in large doses.

The second boy came under observation at the Polyclinic Hospital, November 22, 1914, complaining of knock-knee on the right side. He walked with his toes turned in and his mother noticed this condition for nine months, there was at this time no limitation of motion and the X-ray showed Perthes's disease of the left side. Subsequently, the same condition developed on the other side, in five months. He was treated similarly to the first case and he has now good functional use of the thigh.

Perthes's disease is characterized by atrophy of the upper epiphyses of the femur, due to a subchondral area obstruction, which eventually becomes complete; there is no temperature; there is slight limp, prominence of the great trochanter, some atrophy of the muscles and limitation of abduction, with slight pain from time to time. The patient does not respond to the tests for tuberculosis. After remaining active for a year or more there is a tendency to recovery with slight functional changes.

## OSTEOCHONDRITIS DEFORMANS JUVENILIS

The X-rays in the second case are characteristic, and show a flattening and broadening of the head, with a moderate degree of coxa vara. The etiology is obscure, but Legg believes in a traumatic etiology, with "blocking of the blood supply to the epiphysis, due to trauma of the epiphysial line."

DR. GWILYM G. DAVIS said that it is easy enough to diagnose in various affections the well-advanced typical cases, but the trouble comes in atypical ones, such as when we see a child running around with perhaps just a slight or no pain and perhaps a rather marked limp who does not progress apparently beyond that stage. It is possible to conceive of there being a number of possible conditions; for instance, the symptoms may be the result of a rhachitic state, such as bone softening. In arthritis deformans we find in some cases very similar conditions. It is perfectly well known also that in the adult it is not uncommon to find cases of atrophy, especially of the neck of the femur, from injury. Without doubt, following an injury there sometimes follows disturbance of nutrition in the head and in the neck of the femur, which gives rise to local changes. One might call this an osteitis or osteochondritis, but it is hard to determine the exact pathology of the affection. In some of the reported cases changes have been observed in other joints. That would argue a rhachitic condition or one of more or less general disturbance.

Examination from a pathological stand-point shows the absence of any specific taint, the Wassermann and von Pirquet tests being negative. An X-ray plate may be made and if the disease has progressed far enough certain changes may be evident in the head of the bone. To tell, however, the exact character of these cases is very difficult because of the changes being so slight. That which is to be especially guarded against is that we do not mistake an early case of tuberculosis for this condition and permit too great activity. Many of these cases are found to have been preceded by traumatism. One marked case of his appeared almost like a separation of the epiphyses of the head of the femur. The boy presented an appearance of retarded development, almost infantilism. The question arose whether or not he had a more or less general bone softening, with lack of development, in which the local conditions were caused by an accident. If an accident is the sole cause in such a condition in a healthy individual, spontaneous recovery ought to occur; but, if the accident is only an incident in a constitutional disturbance, the case requires entirely different handling, and the proper management of these cases is by no means established, nor have we decided upon any distinct line of treat-

#### PHILADELPHIA ACADEMY OF SURGERY

ment to pursue. It would be wise to protect the joint as much as possible and then endeavor to improve the general condition.

DR. ASTLEY P. C. ASHHURST presented an X-ray picture (Fig. 1) of a patient, now eighteen years of age, showing a flat head of the femur. This young man says that when five years old he had a multiple arthritis, which laid him up for about a year. When he got about he was lame in the right hip, and has been lame ever since, but has never been laid up. There is shortening of 1.5 cm., and the thigh is 5 cm. less in circumference than the left. Flexion of the hip is slightly limited, internal rotation is lost, and there is almost complete loss of abduction. The question is, is every case of flat-headed femur an example of so-called Perthes's disease?

Dr. Davis has reminded us that Perthes was not the first to describe the condition. One of the studies of this affection which caught his own attention first was by Calvé, in the *Revue de Chirurgie* for 1910; he called it a "particular form of pseudocoxalgia." A case of coxa vara at the Episcopal Hospital in 1913 was thought to be an example of this affection (Klauder: *Medical and Surgical Reports of the Episcopal Hospital*, 1914, ii, 269).

It must be remembered that for very many years all forms of hip disease were undifferentiated. Then the tuberculous nature of many of them became recognized, and for a time many surgeons considered all cases of hip disease tuberculous. It is only within a comparatively few years that it has been possible to disprove the tuberculous nature of some cases, and among these non-tuberculous cases of hip disease we must place instances of Calvé's or Perthes's disease; but of their true pathogenesis we are still in doubt.

DR. YOUNG, in closing, said that there has been too much confusion in regard to the nomenclature of diseases of the hip. The term hip disease should be used exclusively for tuberculosis of the hip-joint and then there would be less confusion. The term osteochondritis deformans infantilis is a good one, but the term Perthes's disease has been commonly used by orthopædic surgeons, and as his description was the first systematic and complete one, it is not improper to designate this condition as Perthes's disease.

#### UNUNITED FRACTURE OF THE LUMBAR VERTEBRÆ

DR. JAMES K. YOUNG presented a man, aged thirty years, who sustained an injury to his lumbar region by falling from a height and striking his spine upon a track of the railroad, ten years ago, and in



FIG. 1.—Coxa vara (flat head) in a patient aged eighteen years, following arthritis at five years of age.



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#### RECURRENT DISLOCATION OF THE SHOULDER-JOINT

whom a diagnosis had only been reached one year ago. There was great difficulty in getting satisfactory X-rays on account of the large size of the patient. The symptoms during this interval resembled, somewhat, the so-called "railway spine," such as usually accompanies ligamentous injuries. The more recent improvement in the Röntgen technic enabled Dr. Pancoast, of the University of Pennsylvania, to take a picture which shows a fracture on the right side of the transverse processes of the third and fourth lumbar vertebræ, both of which are ununited. It is possible by surgical means to remove both of these, but the condition has so greatly improved, the patient is advised not to submit at the present time to operation.

#### RECURRENT DISLOCATION OF THE SHOULDER-JOINT

DR. JAMES K. YOUNG presented a man who had been operated upon by a new method for recurrent dislocation of the shoulder-joint. The patient was an athletic mulatto, aged twenty years. The shoulder was injured by an overhand throw while playing base-ball, at a western university, in Kansas. The dislocation was subcoracoid, and recurred frequently during the day, interfering with his occupation, which was that of a dentist's helper. The operation which was performed was suggested by Dr. Oscar H. Allis, and consists in dividing the lower half of the insertion of the tendons of the pectoralis major and the latissimus dorsi, and keeping the shoulder in an elevated position until union has occurred. The incision is made between the deltoid and the pectoralis major in front, the cephalic vein is displaced outward, and the attachment of the pectoralis major tendon is found and divided in its lower half. In thin subjects the tendon of the latissimus dorsi can be hooked up from the same incision, but in muscular subjects a second incision must be made along the posterior border of the axilla, until the tendon of the latissimus dorsi is found and its lower half divided. The shoulder is kept elevated for ten days. The patient has had no recurrence of the dislocation since the operation. He also has full strength in the muscles about the shoulder-joint.

This operation appears to be suitable in forward upward dislocations of the shoulder-joint; division of the lower half only of the tendon changes the direction of the action of these two powerful muscles, but does not apparently weaken the action of the muscles about the joint. It will be noticed that the capsule was not sutured, and that the joint was not opened, which obviates one possible source of infection.

PHILADELPHIA ACADEMY OF SURGERY

RUPTURE OF THE SIGMOID BY INFLATION THROUGH THE  
RECTUM

DR. A. D. WHITING reported the following case:

J. W., Pole, male, aged twenty-five, was admitted to the Germantown Hospital, November 11, 1915, at 2.30 P.M. While at work, at 1.20 P.M., in a steel mill, in a stooping position, some of his fellow workmen, in a spirit of fun, placed the nozzle of a compressed air pipe within a few inches of his buttock and directed the compressed air, under eighty pounds pressure, through a three-eighths-inch nozzle toward the anus. The patient staggered and then leaned against a wall, but did not fall. With the assistance of a fellow workman, he walked to the Infirmary of the works, where the attending surgeon found the abdomen markedly distended and very tense. A rectal tube was passed, but no gas escaped through it. A small amount of blood was recovered. He was then sent to the hospital.

When first seen by Dr. Whiting, at about 3.15 P.M., his temperature was 97°, pulse 66, respirations 24. Breathing was difficult. The abdomen was distended and tense, and very tympanitic, with marked rigidity throughout but more pronounced in the upper right quadrant. Owing to the inability of the patient to understand English, a history could not be obtained until an interpreter was summoned. Then the patient denied the inflation of the colon, but stated that he had been seized with sudden upper abdominal pain. A diagnosis of rupture of the stomach or intestine was made and immediate operation advised. Before consent to operation could be obtained, the true history was given by the patient to a priest.

*Operation* (at 6.15 P.M.).—During the interval of five hours between the accident and operation, the patient became very much worse, the respirations were more difficult and the pulse much weaker and more rapid. Incision was made through the lower right rectus. As the peritoneum was opened, there was a gush of air, with blood and fecal matter, followed by immediate improvement in respiratory and heart action, which, however, did not last long. Inspection revealed an opening in the sigmoid, about 3.5 cm. in length, opposite the attachment of the mesosigmoid. This was closed with through-and-through catgut sutures. Further search showed that there had been a tearing of the serous coat of the sigmoid for about 15 cm. The descending colon and rectum were intact. Owing to the poor condition of the patient, it was deemed inadvisable to do a resection. A rapid closure of the rent in the peritoneum was performed, the abdominal cavity was flushed with hot saline, saline solution was adminis-

## LUMBAR HERNIA

tered intravenously, and the wound was closed without drainage. The patient reacted fairly well from the operation, but the improvement was not prolonged; his temperature rose, without remission, to 109°, just before his death, 28 hours after operation.

A post-mortem examination showed complete closure of all the tears of the bowels and the absence of peritonitis. A study of the ruptured bowel shows absence of the usual rugations and irregularities of the mucosa, it being perfectly smooth from the stretching. The mucosa shows two tears, one perforating through the peritoneum, and numerous small ones longitudinal in direction. There are one longitudinal and two transverse tears of the peritoneum. There is evidence of hemorrhage between the bowel coats, and a few areas of punctate hemorrhage.

E. Wyllys Andrews (*Surg., Gyn. and Obs.*, xii, 1911, p. 63) has reported a similar case of his own and the histories of 15 others obtained through correspondence and law reports. In 13 of them the inflation of the bowel was the result of practical jokes; in three no mention is made of this feature of the accident.

In all of Andrews's collected cases, as in the present one, the nozzle of the apparatus was not introduced into the rectum, but simply directed toward the anus, the sides of the funnel formed by the buttocks directing the air into the bowel.

In all of the reported cases the intestinal injury was confined to the colon, and usually to the sigmoid, because, as suggested by Andrews, it "traps the air momentarily by its somewhat bent or kinked junction to the descending colon. It thus sustains the first shock of the pressure and, unable to pass the mass of air onward, it yields to the pressure, dilates, and bursts into the free peritoneal cavity."

The mortality of the condition is 100 per cent. without operation. Immediate coeliotomy with resection or repair of the bowel should reduce the mortality about 75 per cent. In Andrews's collected cases, seven were operated upon with a mortality of 57.2 per cent.

## LUMBAR HERNIA

DR. JOHN SPEESE and EDWARD H. GOODMAN read a paper with the above title.

DR. WALTER G. ELMER said that a case similar to this is in the University Hospital now. It is that of a little boy treated for infantile paralysis of the leg. There is paralysis of the muscles in the flank so that when he coughs there is a hernia about the size of his fist which bulges out just below his ribs on the right side. There appears to be no urgent need for treatment of this condition at present.

PHILADELPHIA ACADEMY OF SURGERY

CONGENITAL ABSENCE OF THE FIBULA<sup>1</sup>

DR. ASTLEY P. C. ASHHURST reported the following case:

In May, 1912, Edgar A., a boy of seven years, came to Dr. Harte's service at the Orthopædic Hospital. He walked on his knees (Fig. 2), owing to congenital absence of the right foot and lower leg, and a congenital malformation of the left foot. The right tibia terminated as a conical stump below what should have been the middle of a normal leg. On the outer side of the right leg was a tab of tissue which could be moved voluntarily, independently of the leg. The right knee-joint was normal, but no fibula was present on this side. On the left side the knee also was normal, but there was no fibula, and the outer two toes and corresponding portions of the foot were absent. The foot was in a position of marked equinovalgus.

Operative correction of the deformities of the left foot was advised, with use of an artificial limb on the right. The parents refused operation, and the child was not seen again until the autumn of 1915, when he was ten years of age. In the meantime his father had made for him a crude artificial limb which he wore on the right leg, and with which he was able to walk moderate distances. The left foot, however, was becoming more and more deformed, and the parents were now willing for operation. The equinovalgus was now much more marked than at his first visit in 1912—the heel was very high, the inner border of the foot was convex, and the outer border was raised until the sole lay at an angle of 45 degrees with the ground. Skiagraphs (Figs. 4 and 5) showed no astragalus, a deformed calcaneum (perhaps an amalgamation of astragalus, calcis and cuboid) in marked outward displacement, and two tarsal bones, perhaps the scaphoid and one of the cuneiforms. The three inner metatarsals with their corresponding phalanges were present. The operation planned was an arthrodesis to hold the calcis under the tibia in the midline, and a transplant from the tibia to form an external malleolus.

*Operation* (by Dr. Ashhurst, September 24, 1915).—Esmarch anæmia. An incision was made down the outer side of the leg, beginning 7 cm. above the ankle-joint, and continued forward parallel to the normal course of the peroneal tendons. A tendon

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<sup>1</sup>One of the most complete discussions of the interesting subject of congenital deformities of the limbs is that by G. Potel, running through the *Revue de Chirurgie* for 1914, vol. xlix. According to his classification the present case is one of hemimelia. Very evidently it is not a case of intra-uterine amputation; witness the deformities of the left lower extremity, and the tab of tissue adherent to the right leg, and representing an abortive attempt to produce foot or toes.





FIG. 2.—Edgar A., seven years old (May 23, 1912). Congenital deformities.



FIG. 3.—Edgar A., ten years old (December 18, 1915). Three months after operation for congenital absence of fibula (equinovalgus).



FIG. 4.—Lateral view of congenital deformity of foot, before operation.



FIG. 5.—Anteroposterior view of congenital absence of fibula and deformity of foot, before operation.



FIG. 6.—Lateral view of foot after operation.

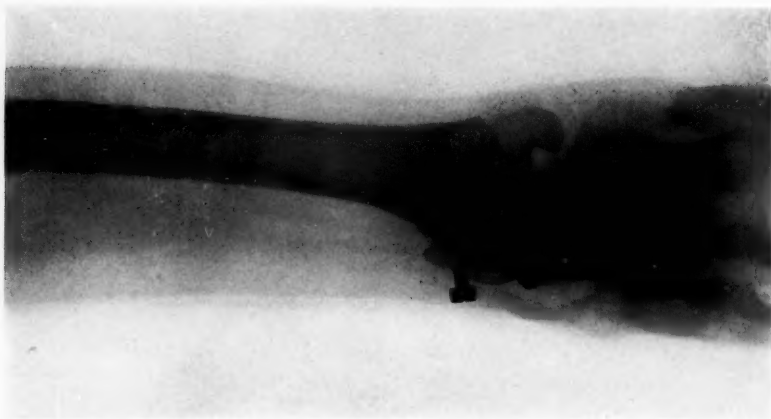


FIG. 7.—Anteroposterior view of foot after operation.

## CONGENITAL ABSENCE OF THE FIBULA

was found inserting in the calcis and the base of the outermost metatarsal bone. This tendon was divided by Z-plasty, for subsequent reunion after lengthening. The calcaneum was held by ligaments very tightly against the outer surface of the tibia, and a large upward projecting portion of the os calcis hindered access to the ankle-joint. A second incision was now made along the Achilles tendon, and this tendon was divided by Z-plasty for subsequent reunion with lengthening. This allowed the heel to be brought down, and made the ankle-joint more accessible. The projecting knob was then cut off the upper surface of the os calcis, and preserved to form an external malleolus; it measured about 4 by 2 by 2 cm. Its removal allowed ready access to the under surface of the tibia and upper surface of the calcis as far as the internal malleolus. The calcis was fully 5 cm. broad, and on account of an inward projection from it beneath the internal malleolus it was not possible to bring it plumb under the narrower tibia. A third incision was then made under the internal malleolus, opening the ankle-joint. After removal of the obstructing projection from the os calcis the latter bone could be brought around horizontally under the tibia in excellent position. Many small chips of bone were purposely left at the outer side of the ankle-joint to fill the slight dead space between tibia and calcaneum. Apart from this no further attempt was made to produce an arthrodesis at the ankle-joint. Next the outer surface of the tibia was removed by chisel, bearing cancellous bone, and the raw bony surface of the large mass first cut from the calcis was applied against this tibial surface, forming a very shapely external malleolus. It was fixed to the tibia by two self-boring Lambotte steel screws. This held the foot in admirable position with great stability. The new external malleolus overlapped the calcaneum, and there was not the slightest inclination to a recurrence of the valgus (Figs. 4, 6, and 7). The peroneal tendon and the tendo Achillis were reunited after suitable lengthening, the Esmarch band was removed, and the wounds closed. The foot was kept in plaster-of-Paris for about ten weeks, when a suitable ankle brace was applied. There is sufficient movement in the ankle-joint, the foot stays in perfect position, and with an artificial leg on the right side the boy is well equipped for locomotion. The ankle brace will be worn for about six months, or until the transplant from the calcaneum has become incorporated with the tibia.

DR. GWILYM G. DAVIS said that he had had a couple of cases similar to this one. In one the leg was considerably shorter than the opposite limb. In this case he bent the foot around until it came straight with the leg and resected at the ankle, putting the end up on the cut tibia

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so that it increased the length of the tibia and made a straight leg. By making an artificial foot the deformity was very much corrected. The other case was that of a young child and in it the tendency of the foot was to swing outward. In such a case when the child is very young, the best management is to correct the valgus by bringing the foot straight, holding it straight with braces with the foot persistently under the leg, so that the leg may accommodate itself to the foot at the ankle-joint. When the child has grown to approximately nine years of age some such operation as Dr. Ashhurst has done can be performed. Of course, the ease of the operation and its efficiency depend upon the amount of growth of bone at the time it is done. The foot can thus be held in its proper relation to the leg without the fibula, and all necessity of apparatus is dispensed with.

### ENDOTHELIOMA OF LEFT FRONTAL LOBE

DR. CHARLES F. NASSAU and DR. GEORGE E. PRICE presented the following case:

Man aged thirty years, a native of Pennsylvania, white and a carpenter by occupation, who was admitted to the service of Dr. Nassau, at the Jefferson Hospital, February 12, 1915.

The family history was negative with the exception of the father's death from cancer of the thigh during the previous summer.

The patient himself gave a history of having had diphtheria, pneumonia and measles in childhood. He denied venereal infection, stated that he used but little alcohol and smoked in moderation. He had been married seven years and had two healthy children. His wife had one miscarriage. With the exception of a trivial accident affecting the left knee, there was no history of the patient having received any injury.

Twelve years ago, he had consulted an oculist because of headache, but after wearing glasses for six months the headache disappeared and he remained free from the trouble for ten years. Two years ago the headache returned, this time being unrelieved by correction of refraction.

In May of last year, he had an epileptiform attack, in which he was found unconscious and with his head turned strongly to the right. A second similar attack occurred one week later, but since this spell he has had no recurrence.

Following these attacks, the headache steadily increased in severity and would often last for days without intermission. The eye-grounds at this time were reported as being negative. Next, his eyesight failed rapidly, and, on December 11, 1914, the local

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surgeon removed a button of bone from the right temporal region without opening the dura. This operation, despite the failure to open the dura, was followed by rapid improvement of vision until about two weeks prior to his admission to the Jefferson Hospital, when it remained stationary. The headache had continued, but with lessened severity. There was no nausea nor vomiting at any time.

Upon examination, some tenderness was noted in the muscles of the left side of the neck near the occiput. There was no bulging at the site of the operation in the right temporal region. The lungs and heart were normal. Over the ninth and tenth dorsal vertebrae was observed a small tumor, not freely movable, but over which the skin could be readily moved.

Urine and blood examinations revealed nothing abnormal and a Wassermann test of the blood serum was reported negative.

An ophthalmological report, made by Dr. Sweet on February 13, 1915, was as follows: Pupils 3.5 mm.; reaction normal to light and convergence. Media clear, tension normal, ocular rotation unimpaired. Both optic nerves covered with exudation, extending several mm. beyond the normal edges; veins tortuous; retinal striations, particularly in R. E. No hemorrhages; swelling R. nerve about 5 D., swelling L. nerve 6 D. from a base of 2 D. Diagnosis: "Choke disk." Visual field shows slight concentric contractions of the right, but none in the left eye. There is enlargement of the blind spot in each eye.

*Neurological Examination.*—Gait and station normal. The pupils were slightly unequal, the right being the larger; both reacted to light and accommodation. There was no nystagmus, external ophthalmoplegia nor hemianopsia. No gross impairment of hearing. Musculature and sensation of face normal. No difficulty in articulation nor in swallowing. There was no aphasia. Grip with both hands fair and equal: no dysmetria; no diadococinesis. The knee-jerks were normal. Upon testing for Babinski's sign, it was observed that the right great toe would sometimes flex, but at other times it would extend. Stroking under the outer malleolus on this side would usually cause extension. On the left side, there was always the normal reflex—flexion. Sensation was everywhere normal. Astereognosis was not present. No mental symptoms were observed and the man's conduct in the ward was said to be that of the ordinary patient.

While the absence of definite symptoms prevented a positive localization, it was felt that this same paucity of localizing symptoms favored a growth in the frontal region, while the turning of the head to the right side in the epileptiform attack and the occasional Babinski on the right side pointed toward a left-sided



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lesion. In accord with this conclusion was the fact that the swelling of the optic disk was most marked on the left side and it was further noted that most of the headache was on the left side, beginning in the temporal region. Accordingly, at operation Dr. Nassau began by turning down a flap on the right side, where the button of bone had been removed in Erie, thinking for safety's sake a decompression could be done on the right side. When the decompression opening was made on the left side, just appearing at the edge of the hole was seen a little bluish-gray appearance of the dura, which was extremely thick. A large portion of the lower inferior angle of the parietal bone was removed with the Rongeur forceps. Bleeding was very profuse, and was controlled with hot packs and Horsley's wax. After incising the dura, a large mass bulged up into the wound anterior to the fissure of Rolando. After starting the separation with the finger, the mass peeled out very well. It left an enormous cavity. Just here he emphasized the wisdom of performing such an operation in two stages when a severe hemorrhage is encountered. If he had finished this operation in one stage, he would have lost his patient. Iodoform gauze was gently packed into the cavity and the scalp brought over the gauze with just one silkworm-gut suture. An enormous Turk's head dressing was applied, using a Halsted gauze roll. Patient was sent to the ward in deep shock. The operation was done February 17, 1915. Five days later, without anæsthesia, he removed the packing from what was then not much of a hole. The wound was closed, with the exception of two small drains. By merely laying gauze in a brain cavity, one does not make injurious pressure, and unless the bleeding is from a large vessel, it will always stop. Of course there should be no visible bleeding point. In mere oozing, one gains nothing by a hard pack on the brain. When the pack was removed, some active bleeding occurred from a vein that was easily tied. March 7, 1915, eye report at this time choked disk, right eye, 1 D, and the left eye  $2\frac{1}{2}$  D. He was now turned over to the Radium Department, and he was treated by Dr. Newcomet for about 8 weeks. There is now absolutely no appearance of any growth whatever. He seems to be perfectly well.

The tumor was examined by Dr. E. D. Funk, who made the following report:

Specimen is an irregular, ovoidal mass of soft, grayish-red tissue, measuring 8 by 5 by 3 cm.; weight 93 gms. One surface is convex and shows slight fissure-like markings. This surface is covered by a thin, smooth, moist membrane. The remaining surface is a torn, rough, dark-red area measuring 1 cm. square, to which a small portion of dura is

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attached. The mass cuts easily and the incised surfaces exhibit a grayish color.

Accompanying the larger mass is a small grayish-white piece of dura measuring 1 cm. square and 0.2 cm. thick.

Specimen was fixed in absolute alcohol, embedded in paraffin, sectioned, and sections stained with hæmatoxylin, eosin and Van Gieson's mixture.

*Histology.*—The sections show many islands of closely arranged cells containing prominent nuclei. These lie in irregular spaces formed by the fibrous connective-tissue stroma.

*Diagnosis.*—Endothelioma.

Dr. Nassau remarked further that tumors of the posterior part of the frontal lobe usually give rise to Jacksonian convulsions by involving the motor area, and on the left side, if the foot of the third frontal convolution, or Broca's area, be invaded, motor aphasia develops.

In the prefrontal region, however, diagnosis is rarely made from any direct focal symptoms. According to Starr, "A decided change in character and disposition, a mental apathy and a tendency to somnolence must be regarded as a sign of frontal lobe disease." Oppenheim states that such psychic disorders as simple dementia and a peculiar face-tiousness, to which he applied the term *witelsucht*, are of frequent occurrence in tumors of the frontal region. Unfortunately, mental symptoms may result from tumors located in other portions of the cerebrum, and, when present in frontal growths, they do not indicate the particular hemisphere in which the neoplasm may be found.

Bruns and Dercum have observed a cerebellar-like ataxia in cases of frontal lesion and Stewart has noted tremor of the extremities on the homolateral side, also loss of the superficial abdominal reflex. None of these findings are constant, however.

In this case, none of the symptoms described above were present. A symptom which had some localizing value was the occurrence of convulsions with turning of the head to the right side. It is well known that irritation of one part of the cerebral cortex may spread or radiate to adjacent parts, which Starr likens to the ripple on the surface of a lake into which a stone has been thrown.

The absence of mental symptoms in this patient may have been due to the character of the growth, as the endothelioma does not actually infiltrate and destroy the brain substance, but growing from the dura it pushes aside the cortex and embeds itself, or makes a nest for itself, in the brain. Moreover, the rate of growth of this variety of tumor is slow and would, therefore, permit of considerable adaptation on the part of the brain to the changed condition.

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Probably no tumor of the brain offers a more favorable outcome to the surgeon than does the endothelioma. Well defined from the surrounding tissue, it is, as a rule, readily removed, and when completely removed the liability to recur is slight. The operator must see to it, however, that the growth is not broken, or if this occurs, great care should be taken to remove all of the tumor, as, should a piece of the growth be left, recurrence is probable.

### PRE-OPERATIVE TREATMENT OF HANDS AND FIELD OF OPERATION

DRS. A. D. WHITING and MORRIS A. SLOCUM read a paper with the above title.

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